CO_2SMO

User's Manual

$ETCO_2/SpO_2$ Monitor

Model 7100

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Catalog No. 5758-23-04

Novametrix Medical Systems Inc.
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About This Manual

The "CO_2SMO $ETCO_2/SpO_2$ Monitor User's Manual" describes the operation and use of the Novametrix CO_2SMO $ETCO_2/SpO_2$ Monitor, Model 7100. The manual is divided into the sections described below.

- "Introduction" on page 3 provides descriptions of the monitor, its controls, connectors and displays.
- "Patient Safety" on page 11 lists important safety information including indications and usage, warnings, and cautions.
- "Monitor Power Up" on page 15 explains how to turn CO_2SMO on and off. AC Mains operation and Battery operation are also explained here.
- "CAPNOSTAT CO_2 Sensor" on page 17 describes the CO_2 sensor, associated airway adapters and other accessories.
- "Monitoring CO_2 and Respiratory Rate" on page 29 describes those monitor features directly related to monitoring $ETCO_2$ and Respiratory Rate.
- "SpO2 Sensors" on page 37 describes the Finger Sensor, the Y-Sensor™ and their accessories.
- "Monitoring SpO_2 and Pulse Rate" on page 51 describes those monitor features directly related to monitoring SpO_2 and Pulse Rate.
- "Alerts" on page 59 provides information on the various monitor alerts.
- "Trend Memory Display" on page 67 details CO_2SMO's trend memory features.
- "Miscellaneous Features" on page 73 describes features not directly linked to specific sections of this manual.
- "Menu Tree" on page 75 diagrams the menu flow of the CO_2SMO.
- "Status Messages" on page 81 lists the various messages that may appear on the CO_2SMO display, and lists possible causes.
- "Using a Printer" on page 85 describes the various printers CO_2SMO supports and the formats of the various printing modes.
- "External Devices" on page 99 describes the various externally conected options available that operate with the CO_2SMO.
- "Maintenance" on page 109 lists monitor, sensor and accessory cleaning and sterilization instructions.
- "Specifications" on page 115 detail the CO_2SMO $ETCO_2/SpO_2$ Monitor, Model 7100.
- "Accessories" on page 117 lists CO_2SMO $ETCO_2/SpO_2$ Monitor, Model 7100 accesories.
- "Typical Capnogram Waveforms" on page 123 provides additional capnogram-related information.

Acknowledgments

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Section 1 *Introduction*

The Novametrix CO_2SMO $ETCO_2/SpO_2$ Monitor, Model 7100, is a lightweight, easy to use, combination capnograph and pulse oximeter monitor designed for use in a variety of clinical settings. It provides reliable measurement, display and alerts for, end tidal carbon dioxide ($ETCO_2$), respiration rate, functional pulsatile oxygen saturation (SpO_2) and pulse rate. The included sampling system allows CO_2 monitoring of non-intubated patients.

Numerical and waveform information is presented on a bright Cold Cathode Display (CCD) with user adjustable contrast to optimize viewing angles. A simple menu system allows user selection of measurement and display options. Alerts are menu programmable or automatic. Presence of a pulse is indicated audibly by a user-selectable “beep”.

Separate 24 hour trends for $ETCO_2$, respiration rate, SpO_2 and pulse rate are updated every 8 seconds. Trend “events” and audible alarm status (Audio Off) are also stored in trend memory.

CO_2SMO has a serial port (RS232) for interfacing to external equipment. The monitor can be powered from the AC Mains or from its rechargeable two-hour battery.

CO_2 Principles of Operation

CO_2SMO measures carbon dioxide and respiratory rate with a unique solid-state device called a CAPNOSTAT CO_2 Sensor. The CAPNOSTAT CO_2 Sensor is placed onto an Airway Adapter and the airway adapter is placed in the patient’s airway circuit—typically between the ventilator elbow and the patient wye (See “CAPNOSTAT CO_2 Sensor” on page 17.) Infrared light is generated in one leg of the “U” shaped sensor and then beamed through the windows of the airway adapter to a detector in the other leg of the sensor. Carbon dioxide, flowing in the airway adapter as a result of respiration, absorbs some of this light energy. The monitor relates the amount of detected energy to the amount of CO_2 in the sample cell (the airway adapter). This results in a capnogram display and numerical values for CO_2 and respiration rate. CO_2SMO uses an adaptive digital detection algorithm system incorporating highly accurate digital filters and adaptive thresholds to cover a wide range of monitoring situations including, rebreathing, neonatal respiratory rates and CO_2 levels, and adult OR and ICU conditions without the operator having to change monitor settings.

Respiration is calculated by measuring the time interval between detected peaks of the CO_2 waveform. The inverse of this measurement is displayed as respiratory rate. Certain rebreathing circuits, or the presence of artifact such as cardiogenic oscillations, may cause CO_2SMO to react to non-respiratory CO_2 fluctuations as if they were breaths—this condition affects only the numerical displays, the Capnogram display continues to provide an accurate picture of the CO_2 waveform. A Respiratory Rate Editor can be enabled to make the instrument more selective in its differentiation of waveforms caused by breathing and those introduced by artifact. As a result, when the editor is in use, the monitor will adapt slowly to sudden changes in respiratory rate.

SpO_2 Principles of Operation

CO_2SMO measures oxygen saturation and pulse rate with sensors that contain red and infrared light sources, called LEDs. Since oxygen saturated blood absorbs different amounts of light at each wavelength (red and infrared) as compared to unsaturated blood, the amount of light absorbed by the blood in each pulse can be used to calculate oxygen saturation.

The light energy from red (660 nm) and infrared (940 nm) LEDs is beamed through a sample cell—a pulsating vascular bed, the patient's finger or toe for example. The remaining light energy not absorbed by the sample cell reaches a light receptor, called a photodiode, on the opposing side of the sensor. The data received at the photodiode is sent back to the monitor where it is split into its red and infrared components, digitized, processed by a microprocessor chip, and finally displayed as a numerical value for oxygen saturation and a plethysmogram.

CO_2SMO is calibrated to display "functional" saturation. This differs from the "fractional" saturation value displayed by most co-oximeters

$$\text{Functional Saturation} = \frac{HbO_2}{100 - (COHb + METHb)}$$

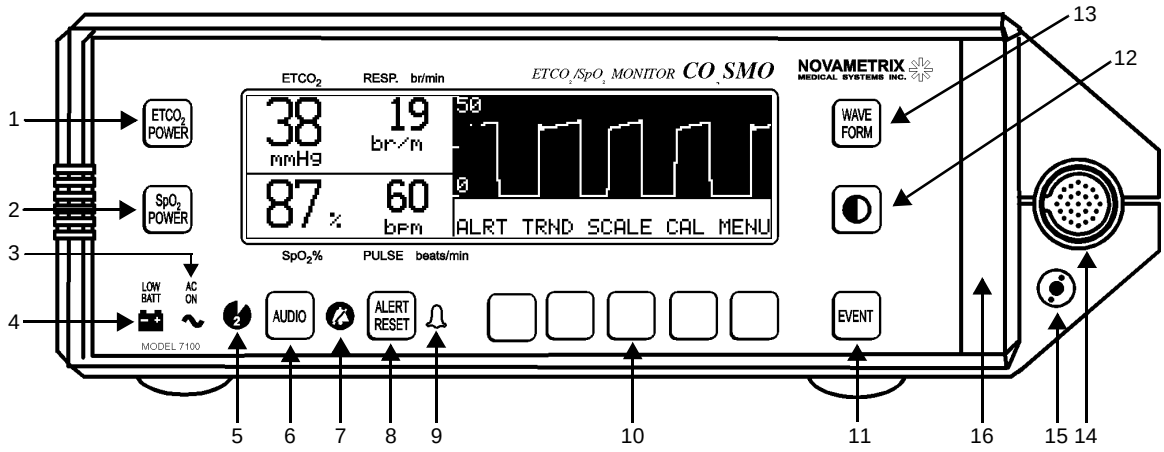
HbO_2 = Fractional Hemoglobin
COHb = Carboxyhemoglobin
METHb = Methemoglobin

Functional saturation represents the amount of oxyhemoglobin as a percentage of the hemoglobin that can be oxygenated. Dysfunctional hemoglobins (COHb and METHb) are not included in the measurement of functional saturation.

Pulse Rate is calculated by measuring the time interval between the peaks of the infrared light waveform. The inverse of this measurement is displayed as pulse rate.

CO_2SMO must be used in conjunction with SuperBright™ saturation sensors. An INCOMP SpO2 PROBE message indicates a non-SuperBright™ Sensor is in use.

Front Panel Controls and Connectors



1 ETCO2 POWER Press to turn CO_2SMO on, or if on, press to turn off $ETCO_2$ portion of monitor. Press in combination with SpO2 POWER to turn unit off.

2 SpO2 POWER Press to turn CO_2SMO on, or if on, press to turn off SpO_2 portion of monitor. Press in combination with ETCO2 POWER to turn unit off.

3 AC ON ∿. If illuminated, CO_2SMO is connected to AC Mains power and charging internal battery.

4 LOW BAT. Illuminates when approximately 15 minutes of battery life remain.

5 (Two Minute Silence). Illuminates when AUDIO key is pressed. Indicates audible alerts are silenced for two minutes.

6 AUDIO Press and release to start Two Minute Silence, or stop Two Minute Silence or Audio Off. Press and hold three seconds to start Audio Off.

7 (Audio Off).Flashes when AUDIO key is pressed for three seconds. Indicates audible alerts have been disabled.

8 ALERT RESET Press to turn off alert indicators. Alerts will reactivate if still valid.

9 (Alert). Flashes red as soon as an alert occurs.

10 Softkeys (5). Perform the action annotated in the Message Center above each key.

11 EVENT Press to mark an "event" in trend memory. When pressed while in the Main Menu the waveform is frozen for sixty seconds. Pressing the **RUN** softkey will return to real time instantly.

12 (Contrast). Press to adjust display contrast for optimum viewing.

13 WAVE FORM Press to switch between capnogram, plethysmogram, or dual waveform displays

14 CO_2 Input Connector. Plug the CAPNOSTAT CO_2 Sensor in here.

15 Sampling System Inlet Connector. The Sampling Airway Adapter tubing plugs in here.

16 Red Alert Bar. Flashes red when alert is latched.

Symbols:

Patient isolation: Identifies connection as type BF

Attention: Consult manual for detailed information

Pb Indicates heavy metal content, specifically lead. Found on the internal battery and monitor enclosure. Refer to qualified service personnel when battery replacement is required.

Recyclable item. Found on the internal battery. Refer to qualified service personnel when battery replacement is required.

250V Mains fuse rating for replacement fuses.

Separate collection. Ensure that spent batteries are collected separately when disposed of. Found on the internal battery. Refer to qualified service personnel when battery replacement is required.

Equipotentiality: Connection to monitor's chassis

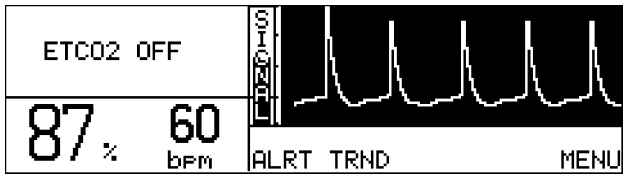
POWER Keys

To turn CO_2SMO on, press *either* the ETCO$_2$ POWER or SpO$_2$ POWER key. To turn the monitor off, press *both* the ETCO$_2$ POWER and SpO$_2$ POWER keys.

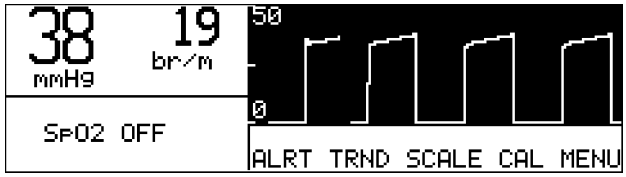
NOTE

CO_2SMO powers up as a combined ETCO$_2$/SpO$_2$ monitor. If only the capnograph or pulse oximeter portion is going to be used, the unused half can be disabled to avoid nuisance alerts and error messages. With the monitor turned on, press either POWER key to shut down that half of the monitor. Press the key again turn that half back on. To turn CO_2SMO off while only one parameter is active, press the power key associated with the active parameter.

Press ETCO$_2$ POWER key to turn off CO_2



Press SpO$_2$ POWER key to turn off SpO$_2$



AC Mains Operation

CO_2SMO uses AC Mains (line cord) power if available and automatically switches to battery operation if AC Mains power is removed or not present. An illuminated AC ON ∿ indicator means the CO_2SMO is connected to AC Mains power and the internal battery is being charged.

To power CO_2SMO from AC Mains (line cord) power; Plug the line cord into the rear panel AC input connector. Set the rear panel power switch to the "|" (ON) position. Plug the other end of the line cord to a properly grounded three-wire outlet.

NOTE

Caution: Ensure the AC ON ∿ indicator is illuminated when operation from AC mains is desired, otherwise power for the monitor is drawn from the internal battery. This can result in the monitor shutting itself off if the battery is allowed to drop to the low battery state. See "Battery Operation" on page 6.

Battery Operation

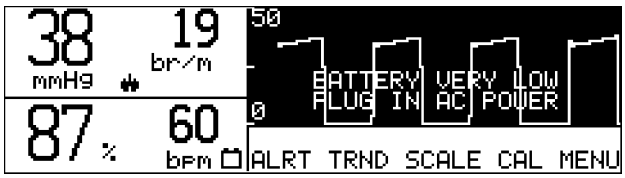
CO_2SMO uses battery power if the line cord is disconnected or the rear panel power switch is set to the "O" (OFF) position. CO_2SMO can operate up to two hours from its internal battery.

While on battery power, CO_2SMO displays a battery icon to the right of the numerical Respiration display. ▮ indicates a fully charged battery, ▬ a half charge, and ▭ indicates less than 30 minutes of battery

life remain. Note: The battery icon may appear fully charged for the first minute after switching to battery power: wait one minute for the icon to truly reflect battery charge.

When approximately 15 minutes of battery life remains, the front panel LOW BAT indicator starts to flash. Reconnect the monitor to the AC Mains to recharge the battery. The monitor can be operated from the AC Mains while the battery is being recharged. The battery will be fully recharged in 12-15 hours.

If the monitor continues operating on battery power while in the low battery state (indicator flashing), the message BATTERY VERY LOW PLUG IN AC POWER is displayed. If the monitor is allowed to continue operation while in the very low battery state, the monitor shuts itself off to prevent damage to the battery and monitor.



NOTE

This alert cannot be silenced by pressing the AUDIO key. The monitor must be connected to AC Mains power to silence the alert condition and recharge the battery. See “AC Mains Operation” on page 6.

AUDIO *AUDIO Key*

Audible alarms can be silenced in two ways; temporarily or permanently.

- Two Minute Alarm Silence: Press the AUDIO key. The (two minute silence) indicator illuminates and audible alerts are silenced for two minutes. After two minutes, the indicator turns off and audible alerts are again allowed to sound. To cancel the two minute silence before the two minutes have elapsed, press the AUDIO key again and the silence condition will be cancelled.
- Permanent Audio Off: Press and hold the AUDIO key until the (audio off) indicator starts flashing*. No audible alerts will be generated. To cancel the audio off condition, press the AUDIO key again: it will stop flashing and audible alerts are again allowed to sound.

ALERT RESET *ALERT RESET Key*

An alert occurs if $ETCO_2$, respiration rate, SpO_2 or pulse rate exceeds the displayed alert limits. Alerts are also generated by conditions such as NO RESP. When an alert occurs, the (alert) indicator flashes, and the violated limit displays and the red alert bar may flash and an alarm may sound. Once the alert condition is fixed, and other flashing displays may continue even though the audible alarms stop.

Press the ALERT RESET key to stop an alert condition that is not currently active. Any alert messages, flashing indicators or audible alerts will be disabled. Currently active alerts will be reset and again become active once any time-out period has elapsed.

In certain conditions such as NO RESP, pressing ALERT RESET will reset (silence) the audible alerts until monitoring is resumed and the monitor again displays end tidal and respiration rate values.

*If AUDIO OFF DISABLED appears when the user activates AUDIO OFF, refer to “Audio Mute” on page 63.

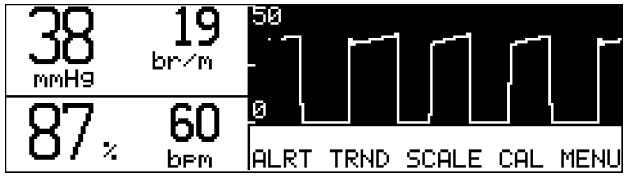
The Menu SOFTKEYS

The Menu Center display area is located just above the five unmarked "softkeys". Softkeys perform the action displayed above each key. For example; above the rightmost softkey in the Main (or Base) Menu is a **MENU** key. Press **MENU** and new menu and softkey functions are displayed. Press **RUN** to return to the Main Menu.

NOTE

RUN always displays the Main Menu. **NEXT** and **PREV** (previous) move through the menus one level at a time. The Main Menu will reappear if no key is pressed for one minute. The time out is extended to five minutes if trends are displayed.

The Main (or Base) Menu is comprised of the following keys :



- **ALRT** - Set alert limits, either manually or with Auto Alerts.
- **TRND** - Trend page menus and displays.
- **SCALE** - Capnogram sweep speed and vertical scale controls
- **CAL** -Airway Adapter calibration menus
- **MENU** -Access CO2 OPTIONS (O_2/$N_2$0 compensation, sampling pump on/off) and SYSTEM OPTIONS (audible alert volume, bright/dim display, averaging time) menus.

EVENT *EVENT Key*

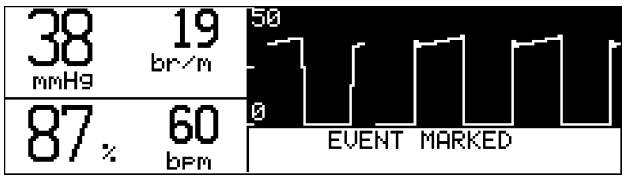
Press the EVENT key to place an "event" marker into the monitor's trend memory. Pressing the EVENT key while in the Main Menu will freeze the waveform for sixty seconds, the message WAVEFORM FROZEN appears on the display. To return to the real time display before the sixty second time out press the **RUN** softkey. Pressing the **EVENT** softkey in menus other than the Main Menu will not freeze the waveform, the event will however be recorded in trend memory. Events are stored in trend memory for use in printouts and trend data examination. The message EVENT MARKED is displayed each time an event is marked.

When the CO_2SMO is configured for operation with a printer and the EVENT key is pressed, PRINT WAVEFORM? will be displayed for approximately 60 seconds. Pressing the **PRINT** key during this time will cause a printout of the waveform. The duration of this printout will be the 10 second interval immediately preceding the pressing of the EVENT key.

When the CO_2SMO is configured for operation with the *NOVACARD* memory module and the EVENT key is pressed, STORE WAVEFORM? will be displayed for 60 seconds. Pressing the **STORE** key will store the

Based on factory default settings.

waveform to the *NOVACARD*. Pressing **ID** will bring up the patient ID menu. The **ERASE** softkey will erase the card. Pressing **RUN** will return to real time display.



CONTRAST Key

Press the (contrast) key to adjust the display for optimum viewing.

WAVEFORM Key

Press WAVE FORM key to display the capnogram, plethysmogram, or dual waveform.

Red Alert Bar

The Red Alert Bar flashes when an alert occurs. The bar can be set to; “latched”, where the bar flashes until the presses **ALERT RESET**; “unlatched”, the bar stops flashing when the alerting parameter returns inside its limits; or “off”, where the bar will not turn on at all.

CAPNOSTAT CO_2 Sensor Input Connector

The CAPNOSTAT CO_2 Sensor plugs into this connector.

CAUTION

Connect only a Novametrix Catalog No. 7167, CAPNOSTAT CO_2 Sensor to the CO_2SMO CO_2 Input Connector. Do not use other CO_2 sensors with the CO_2SMO.

An INCOMPATIBLE CO2 SENSOR message indicates a non-compatible sensor is connected.

Sampling System Inlet Connector

The Sampling Airway Adapter tubing plugs into this connector.

Rear Panel Controls and Connectors

SpO_2 Input Connector

The SpO_2 Sensor plugs into this connector.

CAUTION

Connect only Novametrix SuperBright SpO_2 sensors to the CO_2SMO SpO_2 Input Connector. Do not use other SpO_2 sensors with CO_2SMO.

An INCOMP SpO2 PROBE message indicates a non-compatible sensor is connected.

AC Mains Power Module

The AC Mains line cord plugs into the Power Input Module and is held in place with the line cord retaining clip. The monitor's voltage setting (i.e., 115 VAC) is displayed on the module. When the power switch is set to the "|" position, AC Mains line voltage will power the monitor and recharge the battery (if the line cord is connected). If the power switch is set to the "O" position, AC Mains line voltage is prevented from reaching the monitor's power supply and the monitor must operate from its internal battery.

Sampling System Exhaust Connector

This port is provided so that gas analyzed with the Sampling Airway Adapter and tubing can be scavenged as needed.

Data Communications Port

The "RS232C/Novametrix Accessories" connector provides an interface to external equipment such as a printer and other external optional accessoriesw

Section 2 *Patient Safety*

The CO_2SMO SpO_2 Input is electrically isolated. Patient leakage current flowing from the instrument to ground is limited to less than 10 µA at 120 VAC, 60 Hz. Patient isolation is greater than 10 MΩ, 2500 VAC rms at 60 Hz.

Indications and Usage

The CO_2SMO $ETCO_2$ Monitor, Model 7100, is intended to be used for monitoring end tidal CO_2, respiration rate, functional oxygen saturation and pulse rate in all critical monitoring environments including ventilatory support, patient transport and anesthesia. CO_2SMO is designed to monitor all patients including adult, pediatric and neonatal. CO_2SMO is not intended for any other purpose.

The following factors can influence CO_2 measurement; nitrous oxide, elevated oxygen levels, barometric pressure, water vapor and halogenated agents.

For maximum patient and operator safety, you must follow the following warnings and cautions.

Warnings

WARNING

Indicates a potentially harmful condition that can lead to personal injury

- **Explosion Hazard:** Do NOT use CO_2SMO in the presence of flammable anesthetics. Use of this instrument in such an environment may present an explosion hazard.
- **Electrical Shock Hazard:** Always turn CO_2SMO off, and remove the line cord before cleaning it. Do NOT use a damaged sensor or one with exposed electrical contacts. Refer servicing to qualified service personnel.
- **Failure of Operation:** If the monitor fails to respond as described, do not use it until the situation has been corrected by qualified personnel.
- Do not operate CO_2SMO when it is wet due to spills or condensation.
- Do not operate CO_2SMO if it appears to have been dropped or damaged.
- Keep CO_2SMO and its accessories clean.
- Never sterilize or immerse the monitor in liquids.
- Connect the line cord only to a grounded hospital-grade outlet. CO_2SMO should be connected to the same electrical circuit as other equipment in use on the patient. Outlets on the same circuit can be identified by the hospital's engineering department.
- **Patient Safety:** Care should be exercised to assure continued peripheral perfusion distal to the SpO_2 sensor site after application.

- The CO_2SMO is not intended to be used as a primary diagnostic apnea monitor and/or recording device.
- Inspect the SpO_2 sensor site often for adequate circulation - at least once every four hours. When applying sensors take note of the patient's physiological condition. For example, burn patients may exhibit more sensitivity to heat and pressure and therefore additional consideration such as more frequent site checks may be appropriate.
- **Data Validity:** As with all pulse oximeters, inaccurate SpO_2 and Pulse Rate values can be caused by any of the following:
    - Incorrect application or use of a sensor
    - Significant levels of dysfunctional hemoglobin; carboxyhemoglobin or methemoglobin
    - Significant levels of indocyanine green, methylene blue, or other intravascular dyes
    - Exposure to excessive illumination such as surgical lamps—especially ones with a xenon light source, or direct sunlight
    - Excessive patient movement, venous pulsations, electrosurgical interference
- **Data Validity:** The Pulse Oximeter should not be used as a substitute for an ECG monitor. The oximeter's Pulse Rate display reflects the pulsatile flow found at the patient extremity connected to the sensor. This rate can be affected by many factors and may occasionally be "frozen."
- **Do *NOT*** attach an SpO_2 sensor distal to a blood pressure cuff. Valid data *CANNOT* be processed when the cuff is inflated. Attach the sensor to the limb opposite to the site used for the blood pressure cuff.
- A "NO RESPIRATION" alert is not generated when the CAPNOSTAT CO_2 Sensor is not connected to the monitor.
- The CO_2SMO has no protection against the ingress of water.

Cautions

CAUTION

Indicates a condition that may lead to equipment damage or malfunction.

- Do not operate CO_2SMO when it is wet due to spills or condensation.
- Do not operate CO_2SMO if it appears to have been dropped or damaged.
- Never sterilize or immerse the monitor in liquids.
- Do not sterilize or immerse sensors except as directed in this manual.
- Tension should not be applied to the sensor cable.
- Overstretching the pulse oximeter finger sensor can damage the sensor and potentially affect pulse oximeter readings. Do not stretch the finger sensor open beyond the limit for which it was designed. Overstretching can be prevented: avoid opening the sensor by any means other than squeezing the grips; Do *NOT* force the sensor onto large objects such as the bed rail.
- In case of interference with our equipment or another manufacturer's equipment, notify your Novametrix representative.
- **Do *NOT*** attach an SpO_2 sensor distal to a blood pressure cuff. Valid data *CANNOT* be processed when the cuff is inflated. Attach the sensor to the limb opposite to the site used for the blood pressure cuff.
- Care should be exercised to assure continued peripheral perfusion distal to the SpO_2 sensor site after application

- Do not store the monitor or sensors at temperatures less than 14° F (-10° C) or greater than 131° F (55° C).
- Do not operate the monitor or sensors at temperatures less than 50° F (10° C) or greater than 104° F (40° C).
- Caution: Federal (U.S.A.) law restricts this device to sale, distribution, or use by or on the order of a licensed medical practitioner.

NOTES

Indicates points of particular interest or emphasis for more efficient or convenient operation.

- Components of this product and its associated accessories which have patient contact are free of latex.
- After the life cycle of our equipment and all accessories has been met, disposal of the equipment should be accomplished following the national requirements. Contact the local Novametrix representative for questions concerning disposal.

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Section 3 Monitor Power Up

This section explains how to turn the CO_2SMO on and off. It also explains AC Mains and battery power operation.

Monitor Power Up

1. Verify CAPNOSTAT CO_2 and SpO_2 Sensor integrity.

   Ensure sensors and their extension cables are physically intact with no broken, frayed or damaged components.

2. Plug the CAPNOSTAT CO_2 Sensor into the front panel input connector.

CAUTION

Connect only a Novametrix Catalog No. 7067 or 7167, CAPNOSTAT CO_2 Sensors to CO_2SMO. Do not use other CO_2 sensors with the CO_2SMO.

3. Plug an SpO_2 sensor (or extension cable) into the rear panel input connector.

CAUTION

Connect only Novametrix SuperBright SpO_2 sensors to the CO_2SMO. Do not use other SpO_2 sensors with CO_2SMO.

4. To turn CO_2SMO on, press either the $ETCO_2$ POWER or SpO_2 POWER key.

   Ensure all displays and indicators illuminate briefly. Ensure a "beep" sounds to indicate that the audio is working. Verify a "Self Test in progress" appears followed by the main menu.

   CO_2SMO powers up as a combined $ETCO_2/SpO_2$ monitor. If only the capnograph or pulse oximeter portion is going to be used, the unused half can be disabled to avoid nuisance alerts and error messages. With the monitor turned on, press either power key to shut down that half of the monitor. Press the key again turn that half back on.

5. Press the ◐ (contrast) key to adjust the display for optimum viewing.

6. Press **YES** to erase or press **NO** to retain stored trend information.

   "ERASE STORED TRENDS?" is briefly displayed after power on. Press **YES** to erase the trend data stored during previous monitoring episodes. To keep the stored trend data intact, press the **NO** key (or don't press any key and let the menu time out).

Monitor Power Down

1. To turn CO_2SMO off, press both the ETCO$_2$ POWER and SpO$_2$ POWER keys.

   To turn CO_2SMO off while only one parameter is active, press the power key associated with the active parameter.

AC Mains Operation

CO_2SMO uses AC Mains (line cord) power if available and automatically switches to battery operation if AC Mains power is removed or not present. An illuminated AC ON indicator means the CO_2SMO is connected to AC Mains power and the internal battery is being charged.

To power CO_2SMO from AC Mains (line cord) power; Plug the line cord into the rear panel AC input connector. Set the rear panel power switch to the "|" (ON) position. Plug the other end of the line cord to a properly grounded three-wire outlet.

Battery Operation

CO_2SMO uses battery power if the line cord is disconnected or the rear panel power switch is set to the "O" (OFF) position. CO_2SMO can operate up to two hours from its internal battery.

While on battery power, CO_2SMO displays a battery icon to the right of the numerical Respiration display. indicates a fully charged battery, a half charge, and indicates less than 30 minutes of battery life remain. Note: The battery icon may appear fully charged for the first minute after switching to battery power: wait one minute for the icon to truly reflect battery charge.

When approximately 15 minutes of battery life remain, the front panel LOW BAT indicator starts to flash. Reconnect the monitor to the AC Mains to recharge the battery. The monitor can be operated from the AC Mains while the battery is being recharged. The battery will be fully recharged in 12-15 hours.

If the monitor continues operating on battery power while in the low battery state (indicator flashing), the message BATTERY VERY LOW PLUG IN AC POWER is displayed. If the monitor is allowed to continue operation while in the very low battery state, the monitor will alert, then shut itself off to prevent damage to the battery and monitor.

NOTE

This alert cannot be silenced by pressing the AUDIO key. The monitor must be connected to AC Mains power to silence the alert condition and recharge the battery. See "AC Mains Operation" on page 6.

Section 4 *CAPNOSTAT CO_2 Sensor*

This section explains how to select an airway adapter based on the patient to be monitored, connect the airway adapter to the CAPNOSTAT CO_2 Sensor and to the patient's airway circuit, and how and when to calibrate the airway adapter and sensor.

Airway Adapter Selection

Select an airway adapter based on the patient and monitoring situation.

- Adult Airway Adapter (Catalog No. 7007)
  For patients with Endotracheal Tube diameters greater than 4.0 mm.
- Single Patient Use Adult Airway Adapter (Catalog No. 6063)
  For single patient use with Endotracheal Tube diameters greater than 4.0 mm.
- Single Patient Use Adult Airway Adapter with Mouthpiece (Catalog No. 6421)
  For single patient use for spot checking CO_2 on non-intubated adult or pediatric patients.
- Neonatal Airway Adapter (Catalog No. 7053)
  For patients with Endotracheal Tube diameters less than or equal to 4.0 mm.
- Single Patient Use Neonatal Airway Adapter (Cat. No. 6312)
  For monitoring intubated patients with an ET tube size of 4.0 or smaller.
- Sampling Airway Adapter with tubing (Catalog No. 5843)
  For non-intubated patients when used in conjunction with a nasal sampling cannula.

Adult Airway Adapter

The Adult Airway Adapter (Catalog No. 7007) should be used when monitoring patients with Endotracheal Tube diameters greater than 4.0 mm. Alternatively, the Single Patient Use Adult Airway Adapter (Catalog No. 6063) may be used. See "Single Patient Use Adult Airway Adapter" on page 19.

1. Verify the windows are clean and dry. Clean or replace the adapter if necessary.
2. Snap the airway adapter into the CAPNOSTAT CO_2 Sensor.

   Align the arrow on the bottom of the airway adapter with the arrow on the bottom of the CAPNOSTAT CO_2 Sensor. Press the sensor and airway adapter together until they "click".
3. If necessary, perform an adapter calibration. Otherwise, skip this step.

   Adapter Calibration needs to be performed each time you switch airway adapter types—for example; if you switch from using an Adult to a Neonatal adapter, but not if you switch from an Adult adapter to another Adult adapter. Adapter Calibration should also be performed if the monitor displays ADAPTER CAL?.

   To perform an Adapter Calibration:

Press **CAL**. PLACE ON ADPT IN RM AIR message appears.

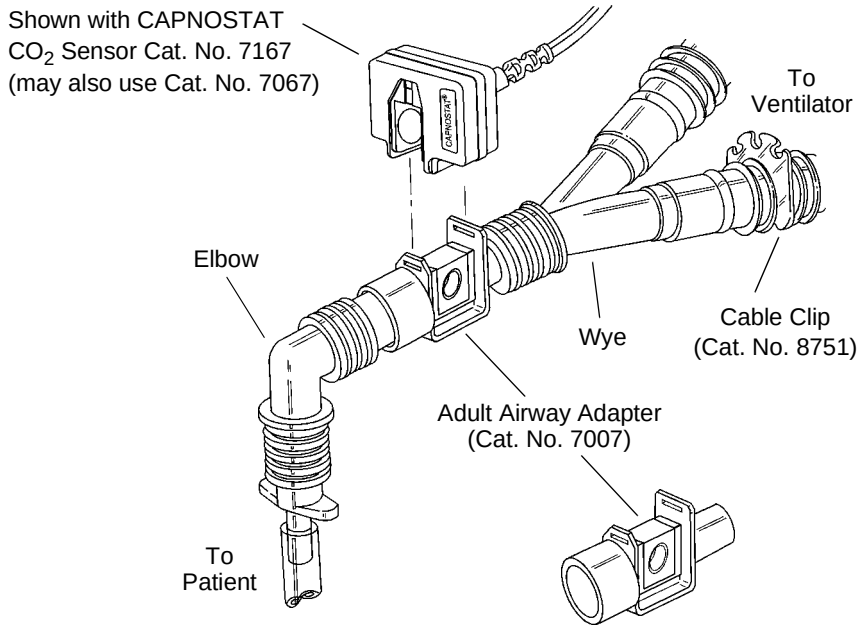
Place the sensor and airway adapter away from all sources of CO_2 (including the patient's—and your own—exhaled breath, and ventilator exhaust valves).

Press **START**. TIME REMAINING counts down and the Main Menu reappears. The actual calibration will take typically less than 15 seconds.

NOTE

If the monitor detects changing CO_2 levels (breaths) during an adapter calibration, BREATHS DETECTED? is displayed followed by PLACE ON ADPT IN RM AIR. To continue, remove the source of CO_2, wait 30 seconds, and press **START**.

4. When using the Adult Airway Adapter, place the CAPNOSTAT CO_2 Sensor/Airway Adapter assembly at the proximal end of the airway circuit between the elbow and the ventilator circuit wye.



NOTE

- For optimal results, do NOT place the airway adapter between the ET tube and the elbow, as this may allow patient secretions to block the adapter windows.
- Position the Airway Adapter with its windows in a vertical and NOT a horizontal position: This helps keep patient secretions from "pooling" on the windows. If pooling does occur, the airway adapter may be removed from the circuit, rinsed with water and reinserted into the circuit.
- To prevent "rain-out" and moisture from draining into the Airway Adapter, do NOT place the Airway Adapter in a gravity dependent position.

5. Check that the connections have been made correctly by verifying a proper CO_2 waveform (capnogram) on the monitor display.

6. The sensor cable should face away from the patient.

To secure the sensor cable safely out of the way, attach Sensor Cable Holding Clips to the airway tubing, then connect the sensor cable to the clips (Cat. No. 8751).

7. See "Monitoring CO_2 and Respiratory Rate" on page 29.

Single Patient Use Adult Airway Adapter

The Single Patient Use Adult Airway Adapter (Catalog No. 6063) should be used when monitoring patients with Endotracheal Tube diameters greater than 4.0 mm. Alternatively, the (reusable) Adult Airway Adapter (Catalog No 7007) may be used. See "Adult Airway Adapter" on page 17.

WARNING

The Single Patient Use Adult Airway Adapter is intended for single patient use, do not re-use or sterilize the adapter as system performance may be compromised.

1. Remove the adapter from the package. Verify the adapter is intact.
2. Snap the Single Patient Use airway adapter into the CAPNOSTAT CO_2 Sensor. It will click into place when properly seated.
3. Perform an adapter calibration.

   Adapter Calibration needs to be performed each time you switch airway adapter types—for example; if you switch from using a Neonatal to a Single Patient Use Adult adapter, but not if you switch from one Single Patient Use Adult adapter to another Single Patient Use Adult adapter. Adapter Calibration should also be performed if the monitor displays ADAPTER CAL?.

   To perform an Adapter Calibration:

   Press **CAL**. PLACE ON ADPT IN RM AIR message appears.

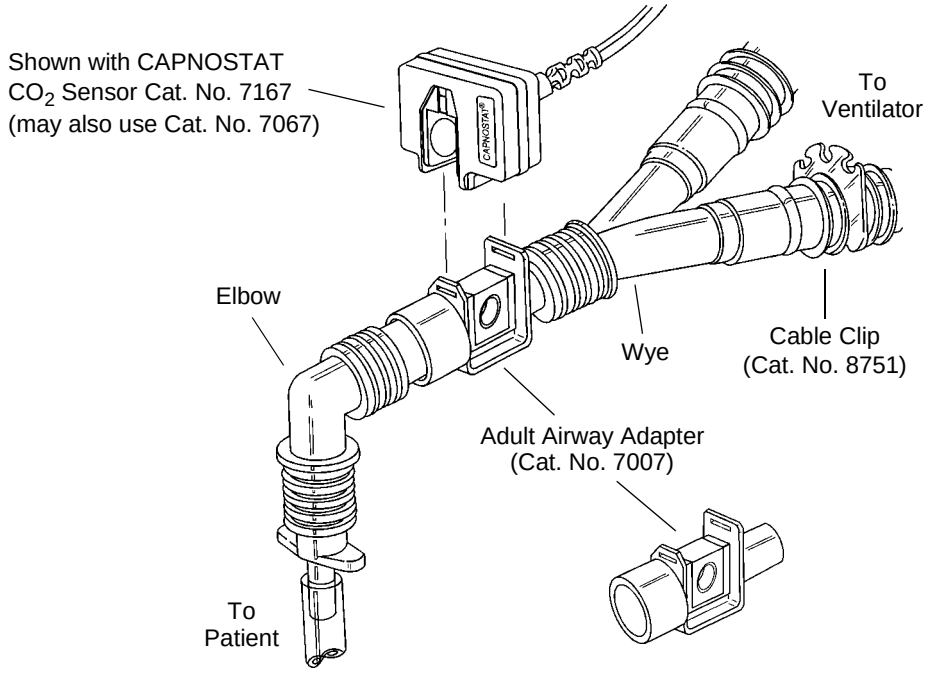
   Place the sensor and airway adapter away from all sources of CO_2 (including the patient's—and your own—exhaled breath, and ventilator exhaust valves).

   Press **START**. TIME REMAINING counts down and the Main Menu reappears.
   The actual calibration will take typically less than 15 seconds.

NOTE

If the monitor detects changing CO_2 levels (breaths) during an adapter calibration, BREATHS DETECTED? is displayed followed by PLACE ON ADPT IN RM AIR. To continue, remove the source of CO_2, wait 30 seconds, and press **START**.

4. Install the CAPNOSTAT CO_2 Sensor/Airway Adapter assembly at the proximal end of the airway circuit between the elbow and the ventilator circuit wye.



NOTE

- For optimal results, do NOT place the airway adapter between the ET tube and the elbow, as this may allow patient secretions to block the adapter windows.
- Position the Airway Adapter with its windows in a vertical and NOT a horizontal position: This helps keep patient secretions from "pooling" on the windows. If pooling does occur, the airway adapter may be removed from the circuit, rinsed with water and reinserted into the circuit.
- To prevent "rain-out" and moisture from draining into the Airway Adapter, do NOT place the Airway Adapter in a gravity dependent position.

Single Patient Use Airway Adapter with Mouthpiece

The single patient use airway adapter with mouthpiece (Catalog No. 6421) can be used for spot checking CO_2 on non-intubated adult or pediatric patients.

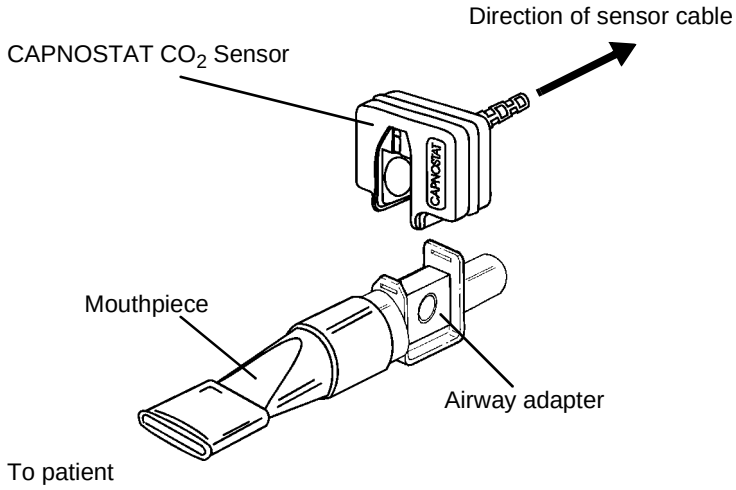
CAUTION

The airway adapter with mouthpiece is intended for single patient use. Do not re-use or sterilize the adapter, as system performance will be compromised.

Instructions for use:

1. Verify that the adapter and mouthpiece are intact and securely fastened to each other.

2. Press the CAPNOSTAT® CO_2 Sensor onto the airway adapter. It will click into place when properly seated. The CAPNOSTAT CO_2 Sensor cable should be facing away from the mouthpiece.



3. Perform an airway zero only if prompted by the monitor.

   An airway zero is not needed if a single patient use adapter had previously been used. An airway zero should be performed only if the monitor displays "ADAPTER CAL?".

   To perform an airway zero:

   3a. Press **CAL**. "PLACE ON ADPT IN RM AIR" message appears.

   3b. Place the sensor and airway adapter away from all sources of CO_2 (including the patient's - and your own - exhaled breath, and ventilator exhaust valves).

   3c. Press **START**. "TIME REMAINING" counts down and the Main Menu reappears. The actual airway zero will typically take less than 15 seconds.

   If the monitor detects changing CO_2 levels (breaths) during an airway zero, "BREATHS DETECTED?" is displayed followed by "PLACE ADPT IN RM AIR". To continue, remove the source of the CO_2, wait 30 seconds, and press **START**.

4. Patient should seal mouth completely around the mouthpiece, then breathe normally.

Neonatal Airway Adapter

The Neonatal Airway Adapter (Catalog No. 7053) should be used when monitoring patients with Endotracheal Tube diameters less than or equal to 4.0 mm.

1. Verify the windows are clean and dry. Clean or replace the adapter if necessary.
2. Snap the airway adapter into the CAPNOSTAT CO_2 Sensor.

   Align the arrow on the bottom of the airway adapter with the arrow on the bottom of the CAPNOSTAT CO_2 Sensor. Press the sensor and airway adapter together until they "click".

3. If necessary, perform an adapter calibration. Otherwise, skip this step.

   Adapter Calibration needs to be performed each time you switch airway adapter types—for example; if you switch from using an Adult to a Neonatal adapter, but not if you switch from

one Neonatal adapter to another Neonatal adapter. Adapter Calibration should also be performed if the monitor displays ADAPTER CAL?.

To perform an Adapter Calibration:

Press **CAL**, PLACE ON ADPT IN RM AIR message appears.

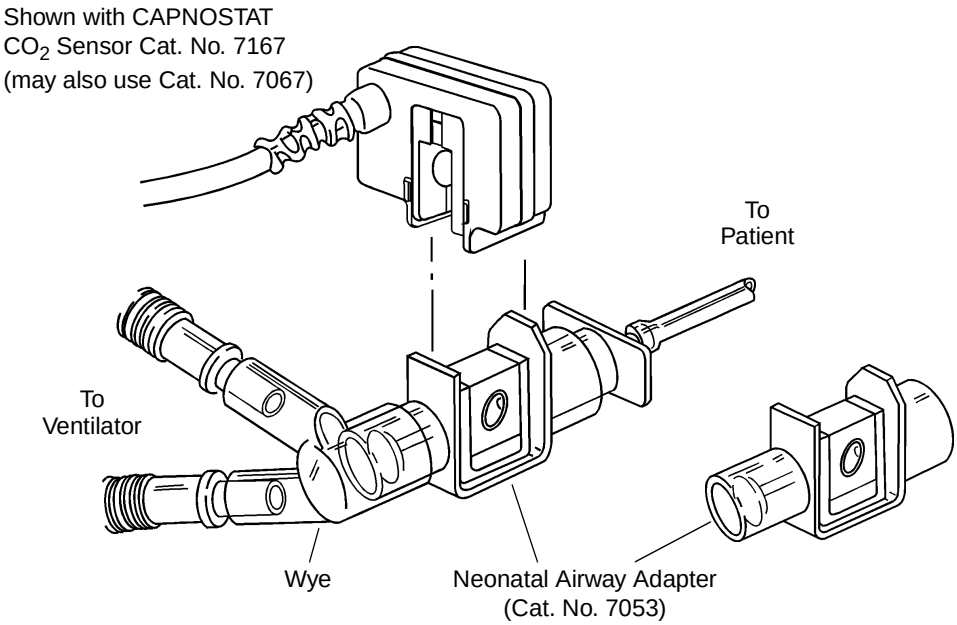
Place the sensor and airway adapter away from all sources of CO_2 (including the patient's—and your own—exhaled breath, and ventilator exhaust valves).

Press **START**. TIME REMAINING counts down and the Main Menu reappears.
The actual calibration will take typically less than 15 seconds.

NOTE

If the monitor detects changing CO_2 levels (breaths) during an adapter calibration, BREATHS DETECTED? is displayed followed by PLACE ON ADPT IN RM AIR. To continue, remove the source of CO_2, wait 30 seconds, and press **START**.

4. When using the Neonatal Airway Adapter, place the CAPNOSTAT CO_2 Sensor/Airway Adapter assembly between the endotracheal tube and the ventilator circuit wye.



NOTE

- For optimal results, do NOT place the airway adapter between the ET tube and the elbow, as this may allow patient secretions to block the adapter windows.
- Position the Airway Adapter with its windows in a vertical and NOT a horizontal position: This helps keep patient secretions from "pooling" on the windows. If pooling does occur, the airway adapter may be removed from the circuit, rinsed with water and reinserted into the circuit.
- To prevent "rain-out" and moisture from draining into the Airway Adapter, do NOT place the Airway Adapter in a gravity dependent position.

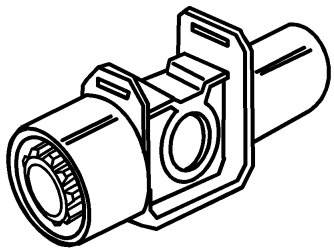
5. Check the connections have been made correctly by verifying a proper CO_2 waveform (capnogram) on the monitor display.

6. The sensor cable should face away from the patient.
7. See "Monitoring CO_2 and Respiratory Rate" on page 29.

Single Patient Use Neonatal Airway Adapter

The single patient use Neonatal Airway Adapter (Catalog No. 6312) should be used when monitoring intubated patients with an ET tube size of 4.0 or smaller with Novametrix CAPNOSTAT® mainstream CO_2 sensors (Catalog No. 7167).

Deadspace: The added deadspace due to the presence of the adapter is less than .5 cc.

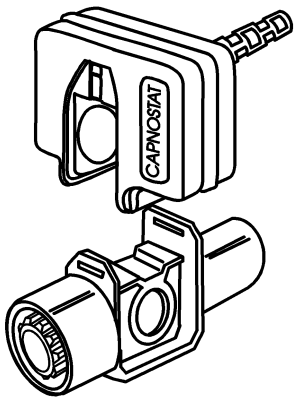


CAUTION

The neonatal airway adapter is intended for single patient use. Do not re-use or sterilize the adapter, as system performance will be compromised.

Instructions for Use:

1. Verify that the airway adapter is intact.
2. Align the arrow on the airway adapter with the arrow on the CAPNOSTAT CO_2 Sensor and press together. It will "click" into place when properly seated.



3. Perform an airway zero only if prompted by the monitor. An airway zero is not needed if a single patient use neonatal adapter had previously been used. An airway zero should be performed only if the monitor displays "ADAPTER CAL?" otherwise, skip this step.

   To perform an airway zero:

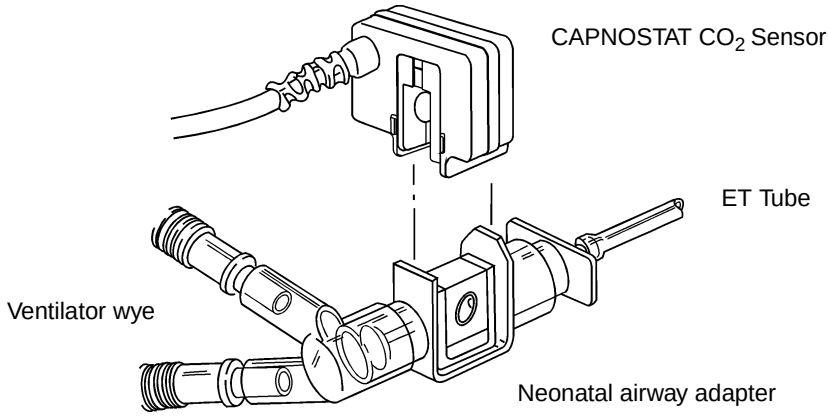
3a. Press **CAL**. "PLACE ON ADPT IN RM AIR" message appears.

3b. Place the sensor with airway adapter away from all sources of CO_2 (including the patient's - and your own - exhaled breath and ventilator exhaust valves.)

3c. Press **START**. "TIME REMAINING" counts down and the Main Menu reappears. The actual airway zero will typically take less than 15 seconds.

If the monitor detects changing CO_2 levels (breaths) during an airway zero, "BREATHS DETECTED?" is displayed followed by "PLACE ADPT IN RM AIR". To continue, remove the source of the CO_2, wait 30 seconds and press **START**.

4. Install at the proximal end of the circuit between the ET tube and the ventilator wye. The cable of the CAPNOSTAT CO_2 Sensor should be facing away from the patient.



NOTE

- Position the airway adapter with its windows in a vertical and NOT a horizontal position: This helps keep patient secretions from collecting on the windows. If pooling does occur, the airway adapter may be removed from the circuit, rinsed with water and reinserted into the circuit.
- For routine performance of airway care, separate the system between the ET tube and the airway adapter. Lavage and suctioning of the airway can then be performed without fluids and mucous accumulating on the neonatal airway adapter windows.

5. Ensure the integrity of the patient breathing circuit after insertion of the airway adapter by verifying a proper CO_2 waveform (capnogram) on the monitor display.

Sampling Airway Adapter

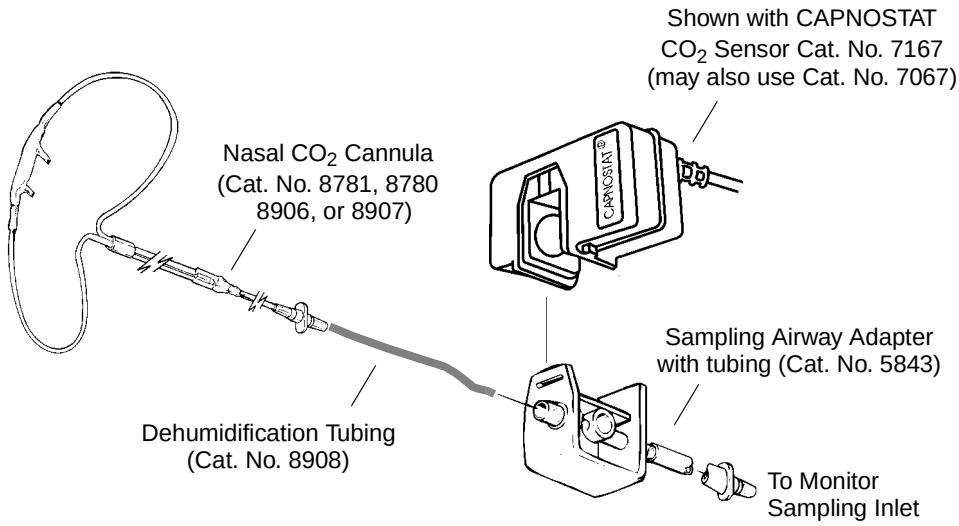
The Sampling Airway Adapter with tubing (Catalog No. 5843) should be used in conjunction with a nasal sampling cannula to monitor non-intubated patients, and to provide sidestream monitoring of pediatric tracheostomy patients.

Non-Intubated Patients

1. Verify the windows are clean and dry. Clean or replace the adapter if necessary.
2. Snap the airway adapter into the CAPNOSTAT CO_2 Sensor.

   Align the arrow on the bottom of the airway adapter with the arrow on the bottom of the CAPNOSTAT CO_2 Sensor. Press the sensor and airway adapter together until they "click".
3. Connect the sampling tubing to the Sampling Inlet port located on the front of the monitor.
4. Connect a Dehumidification Tubing Set to the Sampling Airway Adapter.

   Use of the Nafion® Dehumidification Tubing Set (Cat. No. 8908) is optional. Its use is recommended—especially during high humidity or lengthy monitoring episodes.
5. Connect a Nasal CO_2 Sampling Cannula to the Dehumidification Tubing Set.
   (Or to the Sampling Airway Adapter if not using the dehumidification tubing).



Cat. No.	Cannula Type
8781	Nasal CO_2 Sampling Cannula—Adult
8780	Nasal CO_2 Sampling Cannula—Pediatric
8906	Nasal CO_2 Sampling and O_2 Delivery Cannula—Adult
8907	Nasal CO_2 Sampling and O_2 Delivery Cannula—Pediatric

6. Ensure the sampling pump is turned on—the pump icon ( ) is displayed.

   To turn the sampling pump on (or off):

   Press the **MENU** softkey and CO2 OPTIONS appears.

Press **PUMP** and SET SAMPLING PUMP appears.

Press **ON** to turn the sampling pump on (or press **OFF** to turn the pump off).

7. If necessary, perform an adapter calibration. Otherwise, skip this step.

   Adapter Calibration is necessary when the pump is first turned on; in order to set the sampling system alert thresholds, and to compensate for the unique optical characteristics of the sampling airway adapter. After the first sampling adapter calibration, subsequent patient setups using sampling adapters do not require adapter calibration—so long as the pump is not turned off and similar cannula/dryer tubing combinations are used. Adapter Calibration should also be performed if the monitor displays CAL CO2 CANNULA.

   To perform a Sampling Adapter Calibration:

   - Press **CAL** and CO2 CANNULA ATTACHED ? appears.
   - Verify the cannula (and dryer tubing, if used) is attached to the adapter, and the adapter tubing is attached to the monitor.
   - Press **CONT** (continue) and PLACE ON ADPT IN RM AIR appears.
   - Place the cannula away from all sources of CO_2 (including the patient's—and your own—exhaled breath, and ventilator exhaust valves).
   - Press **START**. TIME REMAINING counts down and the Main Menu reappears.
     The actual calibration will take typically less than 15 seconds.

NOTE

If the monitor detects changing CO_2 levels (breaths) during an adapter calibration, BREATHS DETECTED? is displayed followed by PLACE ON ADPT IN RM AIR. To continue, remove the source of CO_2, wait 30 seconds, and press **START**.

8. If using a Nasal CO_2 Sampling and O_2 Delivery Cannula, attach the O_2 tubing to the administration device and set the device to the prescribed O_2 setting.

9. Position the cannula on the patient.

   Insert the cannula tips into the nostrils, pass the cannula tubing over the ears, then slide the retaining sleeve up the tubing toward the neck to a comfortable fit under chin.

10. Check the connections have been made properly by verifying a proper CO_2 waveform (capnogram) on the monitor display.

11. Using the CAPNOSTAT CO_2 Sensor holding clip, secure the sensor in a convenient place (such as the on the patient's clothing or bedding).

NOTE

If possible, position the Sampling Adapter with its windows in a vertical, and NOT a horizontal position; this helps keep moisture from "pooling" on the windows. If pooling does occur, the airway adapter may be removed from the circuit, rinsed with water and reinserted into the unit.

To prevent "rain-out" and moisture from draining into the Sampling Adapter, do NOT place the Sampling Adapter in a gravity dependent position.

12. Use the twist clips to connect the sensor cable and sampling tubing together, then place them out of the way.

13. See "Monitoring CO_2 and Respiratory Rate" on page 29.

Calibration

Sensor Calibration

The CAPNOSTAT CO_2 Sensor does NOT require calibration at each monitor power up.

Calibration of a particular CAPNOSTAT CO_2 Sensor is necessary only when (1), the monitor requests calibration, and (2), the first time a particular sensor is connected to a particular monitor—as is the case the first time you power up your CO_2SMO and CAPNOSTAT CO_2 Sensor.

Once calibrated, CO_2SMO can be turned off and on, and the CAPNOSTAT CO_2 Sensor can be unplugged and reconnected, without having to recalibrate. However, if a second CAPNOSTAT CO_2 Sensor is connected in place of the original, the new sensor must be calibrated—and if at a later time the original sensor is reconnected, it too will then have to be recalibrated.

To perform a CAPNOSTAT CO_2 Sensor calibration;

1. Verify the CO_2SMO is turned on and the CAPNOSTAT CO_2 Sensor is plugged in.
2. Place the CAPNOSTAT CO_2 sensor onto the ZERO cell. A TIME REMAINING counter is displayed.

   The sensor cable should face away from the CO_2SMO. If WAIT FOR SENSOR appears, the sensor is not at operating temperature (as might be the case if the monitor was just turned on or the sensor was just plugged in). The TIME REMAINING message indicates that the sensor is being calibrated and will usually appear within about one to two minutes. The actual calibration will take typically less than 15 seconds.
3. After the timer counts down, PLACE ON REF CELL appears.
4. Remove the sensor from the ZERO cell and place it on the REF (reference) cell.

   The sensor cable should face away from the CO_2SMO.
5. CHECKING CALIBRATION is displayed.
6. Within several seconds CALIBRATION VERIFIED should appear. Remove the sensor from the cell. The sensor is ready for use.

   If NOT CALIBRATED appears, return the sensor to the ZERO cell and calibration is restarted. If NOT CALIBRATED appears again, or if CALIBRATION ERROR appears, remove the sensor from use and contact the Novametrix Service Department.

Calibration Verification

The user can, at any time, quickly and easily verify CO_2SMO/CAPNOSTAT calibration—and should do so periodically. Calibration verification is also warranted (and easily achieved) if clinical assessment of patient status by alternate means leads to questions of monitor accuracy.

To verify calibration;

1. Verify the CO_2SMO is turned on and the CAPNOSTAT CO_2 Sensor is plugged in.
2. Place the sensor onto the REF (reference) cell.

   The reference cell is the one farthest from the face of the monitor. The sensor cable should face away from the CO_2SMO.
3. CHECKING CALIBRATION is displayed.

   If WAIT FOR SENSOR appears, the sensor is not at operating temperature (as might be the case if the monitor was just turned on or the sensor just plugged in). CHECKING CALIBRATION will usually appear within about one minute.

4. Within several seconds CALIBRATION VERIFIED should appear. Remove the sensor from the cell. The sensor is ready for use.

   If NOT CALIBRATED appears, remove the sensor from the Reference cell and place it on the Zero cell. Calibration is automatically started and, within 15 seconds later, PLACE ON REF CELL should appear. Place the sensor onto the reference cell and within several seconds CALIBRATION VERIFIED should appear.

Adapter Calibration

Adapter Calibration compensates for the optical differences between the Adult, Neonatal and Sampling Airway Adapters.

Adapter Calibration needs to be performed each time you switch airway adapter types—for example; if you switch from using an Adult to a Neonatal adapter, but not if you switch from an Adult adapter to another Adult adapter. Adapter Calibration should also be performed if the monitor displays ADAPTER CAL? or CAL CO2 CANNULA.

Refer to “Adult Airway Adapter” on page 17, “Neonatal Airway Adapter” on page 21, and “Sampling Airway Adapter” on page 25 for specific Adapter Calibration details.

Section 5 *Monitoring CO_2 and Respiratory Rate*

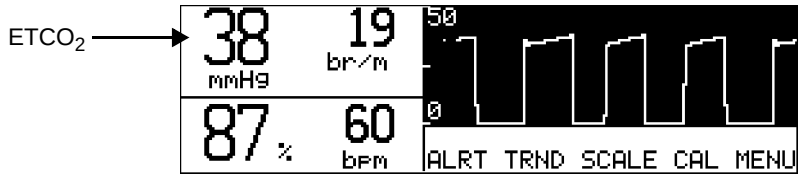
Once the Capnostat CO_2 Sensor and airway adapter are connected to the patient's airway circuit, CO_2SMO displays $ETCO_2$, Inspired CO_2 if present, Respiratory Rate and a capnogram.

Carbon Dioxide

CO_2SMO's Carbon Dioxide display reflects the maximum concentration of CO_2 detected during respiration. This maximum CO_2 concentration usually occurs at the end of expiration, thus the term "End Tidal CO_2" or $ETCO_2$.

End Tidal CO_2

CO_2SMO measures $ETCO_2$ in the range of 0-99 mmHg. The system is accurate to ± 2 mmHg from 0-40 mmHg, and to within 5% of the reading from 40-99 mmHg.

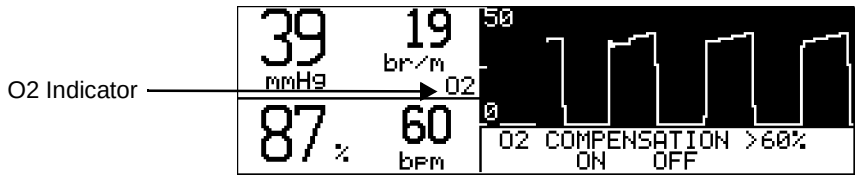


Audible and visible limit alerts are provided for $ETCO_2$. See "Alerts" on page 59.

Oxygen Compensation

Unless compensated for, the presence of oxygen at elevated concentrations affects the measurement of the concentration of CO_2. Typically, unless compensated for, oxygen levels in excess of 60% tend to decrease the displayed CO_2 value by approximately 5% of reading.

CO_2SMO allows the user to enable O_2 Compensation if oxygen levels in excess of 60% are introduced to the airway circuit. O_2 Compensation should be turned off if the O_2 concentration is less than 60%. When O_2 Compensation is active, "O2" is displayed below the respiration rate display.



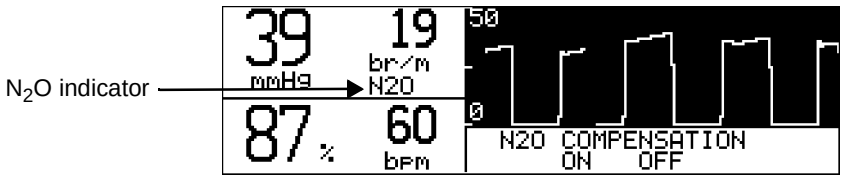
To turn O_2 Compensation on or off:

1. Press the **MENU** key. CO2 OPTIONS appears.
2. Press the **O2** key. O2 COMPENSATION >60% appears.
   The current setting flashes.
3. Press **ON** or **OFF** as desired.
   Press **ON** to activate O_2 Compensation. The O2 icon is displayed.
   Press **OFF** to turn off O_2 Compensation. The O2 icon display is removed.
4. Press **RUN** to return to the Main Menu.

Nitrous Oxide Compensation

Unless compensated for, the presence of nitrous oxide affects the measurement of the concentration of CO_2. Typically, unless compensated for, nitrous oxide in concentrations of 50-70%, tend to increase the displayed CO_2 value by approximately 5% of reading.

CO_2SMO allows the user to enable N_2O Compensation if nitrous oxide is introduced to the airway circuit. N_2O Compensation should be turned off if nitrous oxide is not present. When N_2O Compensation is active, "N2O" is displayed below the respiration rate display.



To turn nitrous oxide compensation on or off:

1. Press the **MENU** key. CO2 OPTIONS appears.
2. Press the **N2O** key. N2O COMPENSATION appears.
   The current setting flashes.
3. Press **ON** or **OFF** as desired.
   Press **ON** to activate N_2O Compensation. The N2O icon is displayed.
   Press **OFF** to turn off N_2O Compensation. The N2O icon display is removed.
4. Press **RUN** to return to the Main Menu.

Barometric Pressure Compensation

Barometric pressure changes (changes in base altitude from sea level) can affect the CO_2 value. CO_2SMO is shipped from the factory with barometric pressure compensation set at 760 mmHg (sea level). If the monitor is used in an area with a different normal barometric pressure, the compensation should be changed to the new pressure value. Normal day-to-day barometric pressure variations should not require adjustment of the monitor's barometric pressure setting.

NOTE

Monitors with version 1.9 software do not support automatic barometric pressure compensation. These monitors can be identified by an "L" in the serial number suffix. Refer to the appropriate section below regarding the variation of version 1.9 software.

To compensate for barometric pressure:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Press the **BARO** (barometric pressure) key. BAROMETRIC PRESSURE appears.

   The current barometric pressure setting (560-780 mmHg) is displayed, and the current selection MANUAL or AUTO will flash.
3. Press **AUTO** or **MANUAL** as desired.

   Press **AUTO** to select monitor's automatic barometric pressure compensation. The monitor will briefly display AUTOMATIC BARO PRESSURE COMPENSATION SELECTED.

   Press **MANUAL** to manually enter barometric pressure compensation. Press ↑ or ↓ to increase or decrease the barometric pressure setting. Rounding to the closest setting results in less than a 0.15% error in the CO_2 value.
4. Press **RUN** to return to the Main Menu.

To compensate for barometric pressure, with revision 1.9 software:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Press the **BARO** (barometric pressure) key. BAROMETRIC PRESSURE =XXX mmHg appears.

   XXX will be the current barometric pressure setting (560-780 mmHg).
3. Press ↑ or ↓ as desired

   Press ↑ or ↓ to increase or decrease the barometric pressure setting. Rounding to the closet setting results in les than a 0.15% error in the CO_2 value.

   Pressing the **PREV** key will display the CO2 SETUP OPTIONS menu.
4. Press **RUN** to return to the Main Menu.

$ETCO_2$ Calculation

CO_2SMO is configured when shipped from the factory to display the highest $ETCO_2$ value measured during the most recent ten seconds of patient monitoring. This sliding ten second calculation period can be extended to 20 seconds. One breath averaging, where the $ETCO_2$ value of each breath is displayed, can also be selected. $ETCO_2$ calculation does not affect Respiratory Rate.

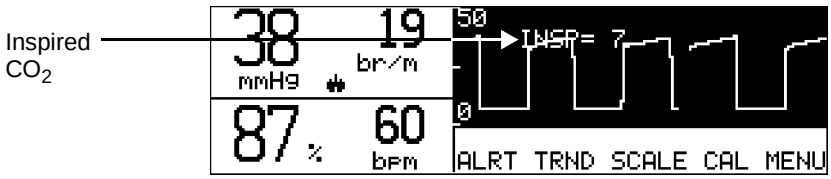
To view or alter the $ETCO_2$ calculation time:

1. Press the **MENU** key. CO2 OPTIONS appears.

2. Press the **NEXT** key. SYSTEM OPTIONS appears.
3. Press the **AVG** (averaging) key. AVERAGING SELECTIONS appears.
4. Press the **CO2** key. SELECT ETCO2 AVERAGING appears.
   The current setting flashes.
5. Press **1BR**, **10s**, or **20s** as desired.
   Press **1BR** to select breath-by-breath $ETCO_2$ display.
   Press **10s** to display the highest $ETCO_2$ value within the most recent 10 seconds.
   Press **20s** to display the highest $ETCO_2$ value within the most recent 20 seconds.
6. Press **RUN** to return to the Main Menu.

Inspired CO_2

CO_2 concentrations measured during inspiration are typically close to 0 mmHg. Rebreathing, whether intentional or not, tends to raise the minimum concentration of CO_2. CO_2SMO automatically displays "Inspired CO_2" if the minimum detected concentration of CO_2 is in excess of 3 mmHg for periods longer than 15 seconds. CO_2SMO displays Inspired CO_2 in the form of "INSP=XX", where XX is the concentration of CO_2. There are no alerts for Inspired CO_2.



CO_2 Display Units

CO_2SMO can display CO_2 values in any of three units of measure, millimeters of Mercury (mmHg), kilo Pascals (kPa), or percent (%).

To change the CO_2 display unit of measure:

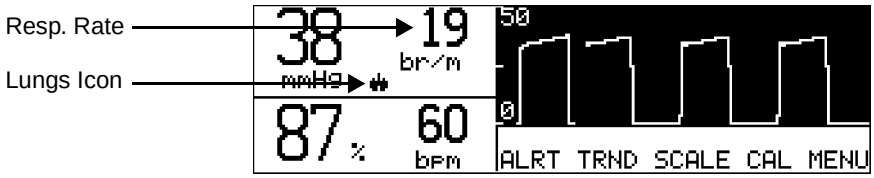
1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Press the **UNITS** key. SELECT CO2 UNITS appears.
   The current CO_2 display unit of measure flashes.
3. Press **mmHg**, **kPa** or **%** as desired.
   mmHg. Display CO_2 in millimeters of Mercury.
   kPa. Display CO_2 in kilo Pascals
   %. Display CO_2 in percent.
4. If the units are changed, UNIT CHANGE ERASES TREND appears.
   Press **CONT** (continue) or **CANCEL** as desired.
   CONT. Change the units display and erase all stored trend data.
   CANCEL. Do not change the display units. Leave stored trend data intact.
   If no key is pressed, the menu times out, and **CANCEL** is selected automatically.
5. Press **RUN** to return to the Main Menu.

Respiratory Rate

CO_2SMO's Respiratory Rate display is the result of averaging the inverse of the eight most recently detected time intervals between CO_2 waveforms.

CO_2SMO measures Respiratory Rate in the range of 0-150 br/min. The display is accurate to ± 1 br/min. The monitor provides audible and visible high and low limit alerts for Respiratory Rate. See "Alerts" on page 59.

With each breath, an icon of a pair of lungs, flashes beside the Respiration display.

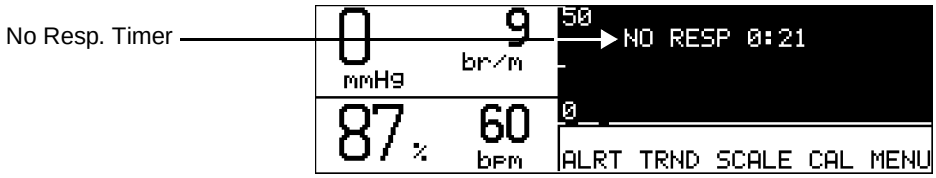


Respiratory Interval Alert

CO_2SMO is equipped with a Respiratory Interval Alert. The "No Respiration" interval alert time is selectable.* The time duration during which no respiration is detected before an alert condition is initiated, can be from 10 seconds to 60 seconds in 5 second increments. See "Selecting the Respiratory Interval Alert Timer Duration" on page 34.

If no respiration is detected during the programmed time duration;

- The CO_2 and Respiration displays are set to zero
- The indicator and Red Alert Bar (unless disabled by the user) starts to flash
- An audible alert sounds (unless audio has been disabled)
- A NO RESP (no respiration) timer appears in the capnogram display area and shows the time in minutes and seconds (10 minute max.) since the last detected respiration.



If respiration resumes;

- CO_2 and Respiration displays will reflect patient status
- Audible and visible alerts will be reset (at the third breath)
- The NO RESP timer will disappear (at the third breath)

*The "No Respiration" interval alert is selectable in software version 2.8 and newer. Earlier versions are set at 20 seconds. Monitors with version 2.8 software are identified by a "CC" in the serial number suffix.

If, during a Respiratory Interval Alert, the user presses ALERT RESET;

- The audible alert and Red Alert Bar are reset
- The 🔔 indicator continues to flash and the NO RESP timer remains displayed.

The Respiratory Interval Alert will not activate until the monitor detects some initial respiration and displays a nonzero Respiratory Rate. This keeps the alert from activating before the sensor is connected to the patient's airway.

Selecting the Respiratory Interval Alert Timer Duration

To select the Respiratory Interval Alert Timer duration:

1. From the Main Menu press **MENU**.
2. When the CO2 OPTIONS screen appears press **NEXT**.

   The SYSTEM OPTIONS menu will appear.
3. From the SYSTEM OPTIONS menu press **AVG**.
4. From the AVERAGING SELECTIONS screen select "No Resp".
5. The NO RESPIRATION TIMER screen will appear.

   From the NO RESPIRATION TIMER screen select the time by using the arrow keys. The time is selectable from 10 seconds to 60 seconds in 5 second increments.

   Press **PREV** to return to the previous menu (AVERAGING SELECTIONS). Pressing the **PREV** softkey will return to the previous screen without saving any changes in the no respiration timer.
6. When the desired time is displayed press the **RUN** softkey to return to the Main Menu.

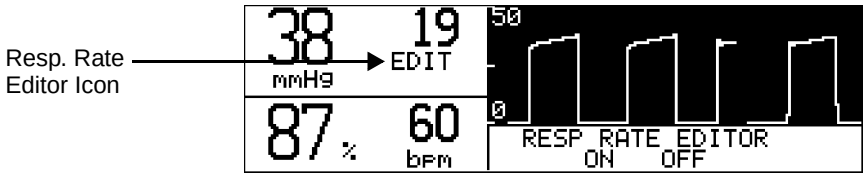
   The displayed time will be saved and the monitor will return to the Main Menu.

Respiratory Rate Editor

Certain rebreathing circuits, or the presence of artifact such as cardiogenic oscillations, may cause CO_2SMO's adaptive digital detection algorithm to react to non-respiratory CO_2 fluctuations as if they were breaths. This condition may cause the monitor's numerical Respiratory Rate display to show values greater than the actual Respiratory Rate. The Capnogram display continues to provide an accurate CO_2 signal.

The Respiratory Rate Editor can be enabled by the user to add additional adaptive waveform duration and amplitude criteria to the detection algorithm. Use of the Respiratory Rate Editor makes the monitor more selective in its differentiation of waveforms caused by breathing and those introduced by artifact. As a result, when the editor is in use, the monitor will adapt slowly to sudden changes in respiratory rate.

To insure the maximum possible sensitivity to changing respiratory rates, it is recommended that the Respiratory Rate Editor be used only in situations in which non-respiratory CO_2 fluctuations, visible in the Capnogram display, are observed to affect the numerical Respiratory Rate display. When the Respiratory Rate Editor is active, "EDIT" appears below the respiratory rate display in place of the "br/m" legend.

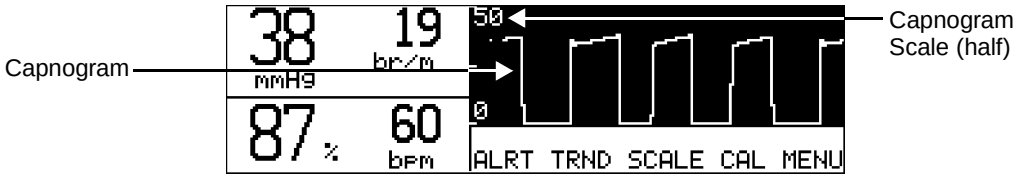


To turn the Respiratory Rate Editor on or off:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Press the **EDIT** key. RESP RATE EDITOR appears.
   The current status of the Respiratory Rate Editor flashes.
3. Press **ON** or **OFF** as desired.
   ON. Turn on Respiratory Rate Editor on.
   OFF. Turn the Respiratory Rate Editor off.
4. Press **RUN** to return to the Main Menu.

Capnogram

CO_2SMO displays a capnogram, a graphic representation of the concentration of CO_2 as a function of time. The user can change the speed at which the capnogram is drawn across the display. The user can also change the capnogram's vertical scale.



Capnogram Speed

To change the capnogram's sweep speed:

1. Press the **SCALE** key. CAPNOGRAM CONTROLS appears.
   If necessary, press [WAVE FORM] to display both the capnogram and the **SCALE** key.
2. Press the **mm/s** key. SWEEP SPEED mm/sec appears.
   The current setting flashes.
3. Select the **6.5**, **13** or **26** mm/sec as desired.
   At 6.5 mm/sec the capnogram show approximately 12 seconds of data.
   At 13 mm/sec the capnogram shows approximately 6 seconds of data.
   At 26 mm/sec the capnogram shows approximately 3 seconds of data.
4. Press **RUN** to return to the Main Menu.

Capnogram Scale

To change the capnogram's vertical scale:

1. Press the **SCALE** key. CAPNOGRAM CONTROLS appears.

   If necessary, press WAVE FORM to display both the capnogram and the **SCALE** key.

2. Press the **SCALE** key.

   The capnogram's vertical scale toggles from 0-50 to 0-75 to 0-100 mmHg with each keypress.

3. Press **RUN** to return to the Main Menu.

Selecting the Instantaneous CO_2 Mode

In the instantaneous CO_2 mode the instantaneous CO_2 value will be displayed and OFF icons will appear in the $ETCO_2$ and Respiration limits screen section. This indicates that the $ETCO_2$ alert limits, and the respiration alert limits are not active (while in the instantaneous mode). When in instantaneous mode the Respiration display will show "INST". When this option is selected the Respiration value will not be shown, the Respiratory Interval Alert Timer timer will also be disabled. See "Respiratory Interval Alert" on page 33.

To select the instantaneous CO_2 mode:

1. From the Main Menu press **MENU**.
2. When the CO2 OPTIONS screen appears press **NEXT**.
3. From the SYSTEM OPTIONS menu press **AVG**.
4. From the AVERAGING SELECTIONS screen press **CO2**.
5. The SELECT ETCO2 AVERAGING screen will appear. Press **INST**, the monitor will return to the previous menu AVERAGING SELECTIONS.

   Selecting **INST** will activate the Instantaneous mode. "INST" will appear in the respiration field, and both respiration and $ETCO_2$ limit alert will be deactivated. Alert disabled icons will appear in the upper corners of the $ETCO_2$ screen section.

   Selection of **1BR** (Single Breath), **10s**, or **20s** will select the $ETCO_2$ mode and use the selected averaging time. The currently set alert limits will still be active (unless the respiration alerts were deactivated in the SET ALERT LIMITS screen).

Monitors with software version 2.8 or newer have the Instantaneous CO2 mode, earlier version software does not support this option.

Section 6 — *SpO_2 Sensors*

This section explains how to select an SpO_2 sensor, how to connect the sensor to the monitor, and how to apply the sensor to that patient.

CAUTION

Connect only Novametrix saturation sensor extension cables and/or SuperBright SpO_2 sensors to CO_2SMO. Do not use other SpO_2 sensors or accessories with CO_2SMO. Before connecting to the patient or to CO_2SMO, ensure sensor extension cables and/or sensors are physically intact, with no broken, frayed or damaged components.

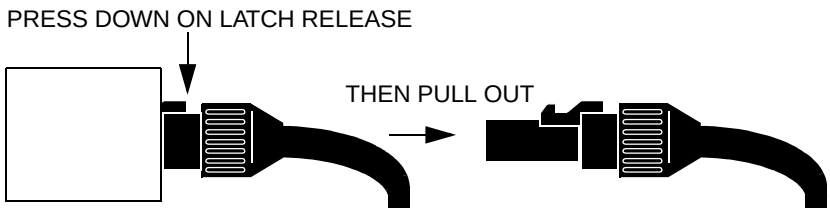
To attach a SuperBright sensor or sensor extension cable to CO_2SMO:

1. Plug the connector into the rear panel SpO_2 Input.

   The connector clicks into place when properly seated. *Do not twist the connector.* Sensors may be connected or removed whether or not the monitor is turned on.

2. To disconnect, press the latch release lever pull the connector from the monitor.

   Do not twist the connector.



Oxy*Snap Connectors*

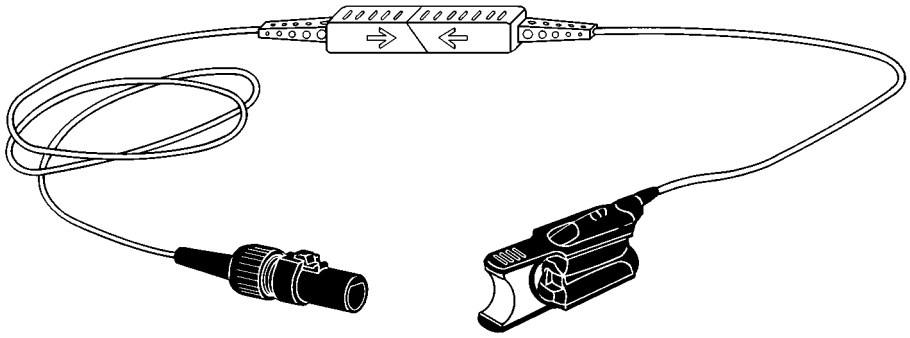
To connect an Oxy*Snap* extension cable to an Oxy*Snap* SuperBright sensor:

1. Align the arrows on the Oxy*Snap* connectors and press the connectors together.

2. To disconnect, grasp the connectors at the finger grips and pull them apart.

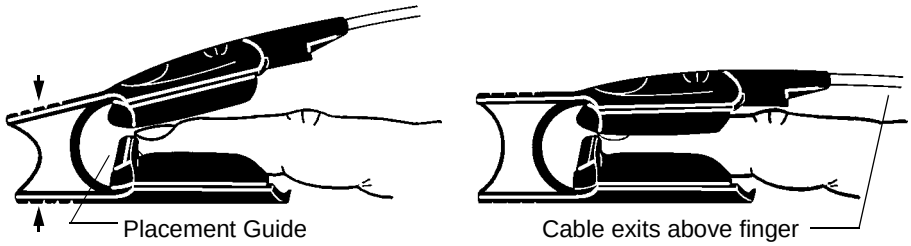
Finger Sensor

The Finger Sensor is intended for adult fingers and not designed for neonatal or pediatric applications.



To apply the finger sensor to the patient:

1. Gently squeeze the grips at the rear of the sensor (indicated by arrows below).



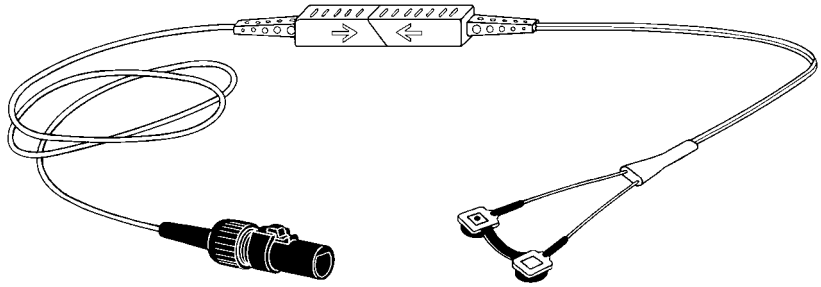
2. Position fingertip against placement guide with fingernail towards the red light.
   Do not position the finger so as to protrude past the placement guide.
3. Release the finger grips.
4. Inspect the site often for adequate circulation—at least once every four hours.
5. To remove sensor, gently squeeze grips and slide the sensor from the finger.

Finger Sensor Quick Check

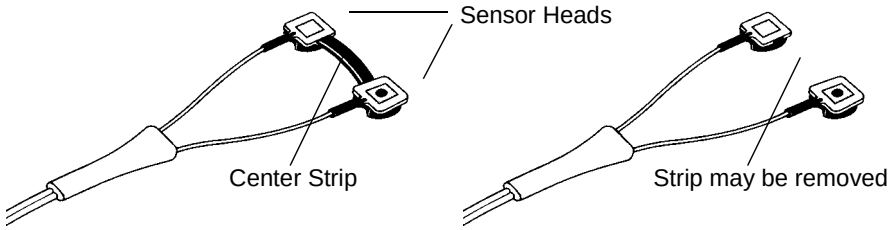
1. Is SpO2 PROBE OFF PT (patient) displayed when the sensor is connected to the monitor but not applied to the patient?
2. Apply the sensor to your index finger. Are reasonable SpO_2 and pulse rate values displayed?
3. A YES to BOTH #1 and #2 indicates the sensor is OK. Apply the sensor to the patient as instructed above.

Y-Sensor

The reusable Y-Sensor is a flexible sensor designed for use on any patient.



The Y-Sensor's Center Strip is not a functional part of the sensor. Its twofold purpose is to aid in the placement of the sensor into the Y-Strip or other securing system and to limit the distance between the sensor heads to no more than 25 mm. The center strip may be removed (carefully cut away) if the distance between the sensor heads needs to be reduced to less than 25 mm.



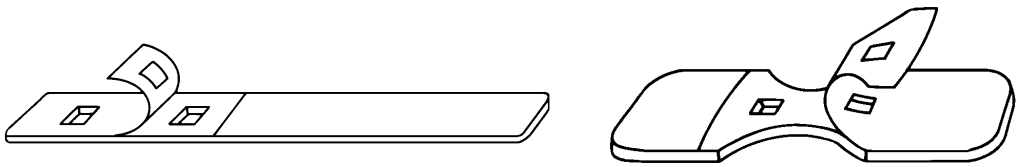
Y-Sensor Application using Wrap Style Tapes

1. Select a Y-Strip based on the patient type and intended sensor location.

   Y-Strips come in two color-coded sizes: 25 mm tapes have green liners, and 20 mm tapes have blue liners. The size refers to the distance between the holes in the tape

Wrap Style Tape		Finger Style Tape	
Cat. No. 8829 25 mm (Green) Neonatal Foot, Hand	Cat. No. 8828 20 mm (Blue) Neonatal Foot, Hand Pediatric Toe, Finger	Cat. No. 8832 25 mm (Green) Adult Finger	Cat. No. 8831 20 mm (Blue) Pediatric Finger Adult Finger

2. Remove the portion of the release liner containing the holes.

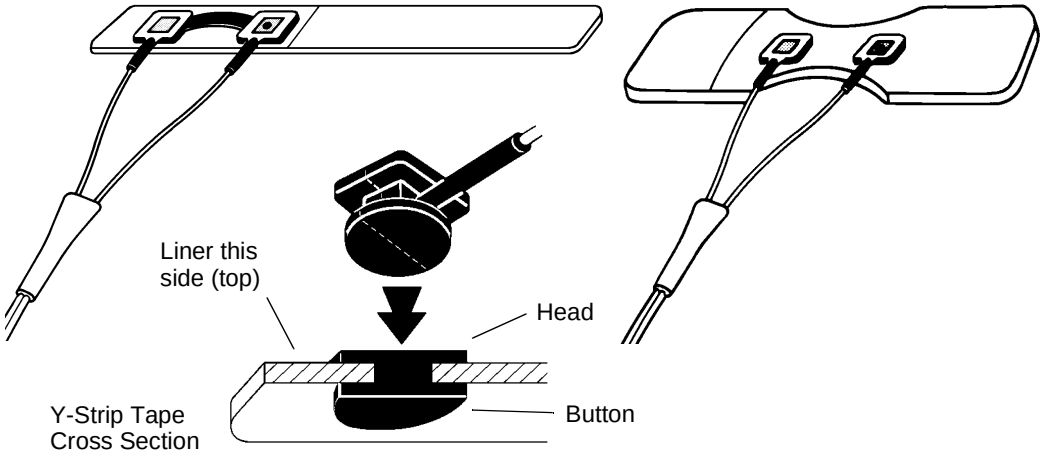


3. *Skip this step if using the 25 mm Y-Strip tape.*
   If using the 20 mm Y-Strip tape, carefully remove the sensor's center strip using a pair of scissors or a sharp blade.

   The center strip does not effect sensor operation, its purpose is to aid putting the sensor into the 25 mm tape and to limit the distance between the sensor heads to no greater than 25 mm.

4. Press the "button", on the back of each sensor head, through a hole in the tape.

   Press in from the sticky side of the tape. The tape will stretch to fit the sensor button.



5. Remove the remaining release liner(s) and apply the sensor/tape to the patient.

   Ensure that the sensor heads are directly opposite each other through the tissue. This prevents the sensor from being placed on a site too thick (high arch) for proper operation.

   Position the sensor so that the tape does not extend over the space between the fingers or toes to insure there will be no light transmission through this space.

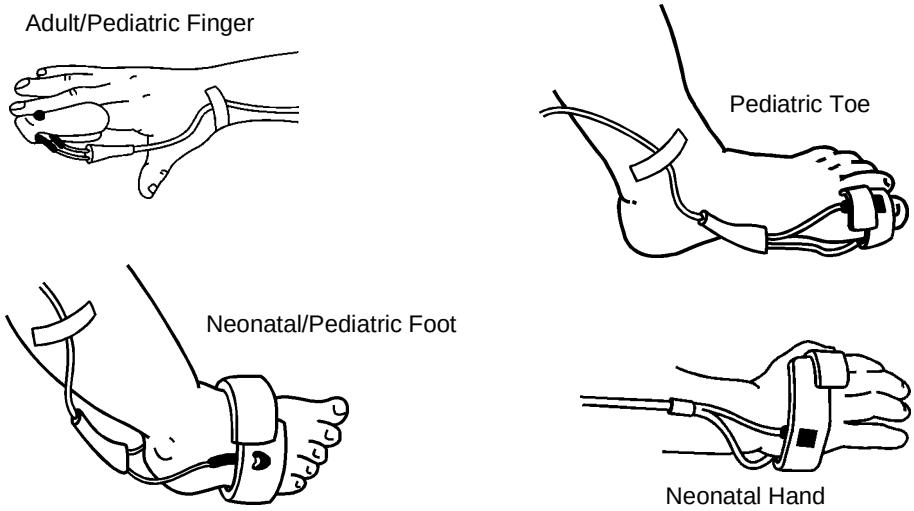
WARNING

Do not wrap the tape around the limb so tightly that circulation is restricted.
Inspect the site often for adequate circulation—at least once every four hours.

Care should be exercised to ensure clinically reasonable alert limit settings are selected. Novametrix does not recommend the setting of limit values to such a wide span as to effectively render alert limit feature useless. Once the limit values are properly set, the user should periodically confirm patient status by alternate means and not rely soley on alerts generated when a limit is violated.

6. To maximize sensor life, secure the sensor to the patient with additional tape.

   Leave slack in the wires between the tape and the sensor.



7. Inspect the site often for adequate circulation—at least once every four hours.

Non-Adhesive Foam Wrap

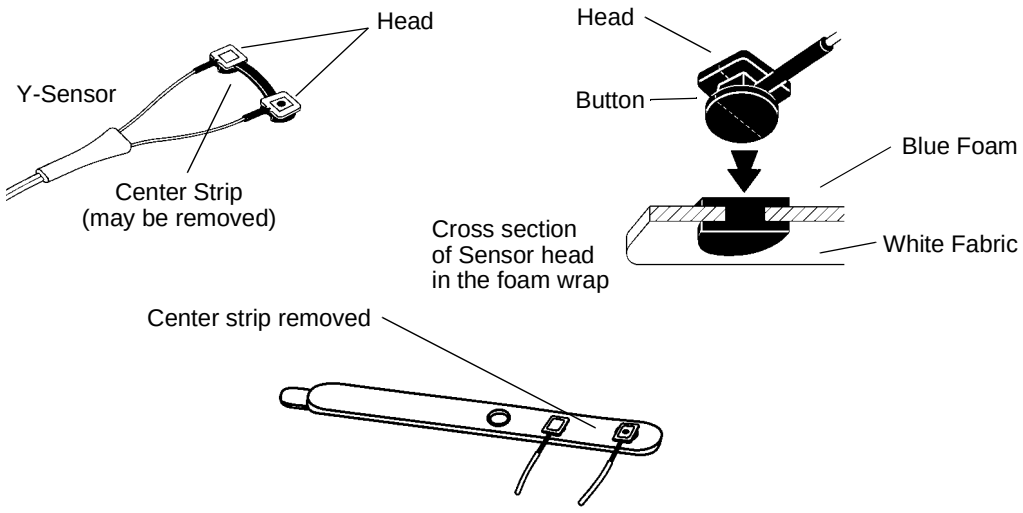
Use the non-adhesive foam wrap with Novametrix SpO_2 Y-Sensor's™ (catalog No. 8793 or 8791).

Select a foam wrap based on the patient type:

- Catalog No. 8836: Large, adult/pediatric finger, neonatal/pediatric foot or hand
- Catalog No. 8943: Small, neonatal foot or hand, pediatric toe or finger

To use the non-adhesive foam wrap:

1. With the blue side of the foam wrap facing up, press the buttons on the back of each Y-sensor head through the holes in the foam wrap. The wrap will stretch to fit the buttons.



NOTE

If using the first and third holes on the foam wrap it may be necessary to cut the middle strip off the Y-sensor.

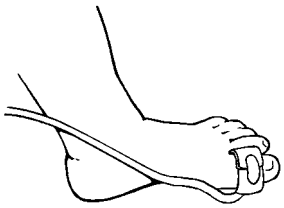
2. Face the blue side of the wrap toward the skin and wrap around the site (cut excess foam if necessary on small version). Secure with the Velcro® tab.

WARNING

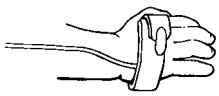
Do not wrap the tape around the limb so tightly that circulation is restricted.
Inspect the site often for adequate circulation—at least once every four hours.

3. *Ensure the sensor heads are directly opposite each other through the tissue.* This prevents the sensor from being placed on a site too thick for proper operation.

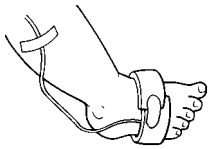
CATALOG NO. 8943 SMALL



Pediatric toe

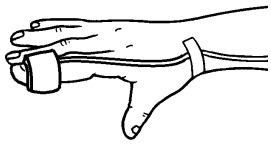


Neonatal hand

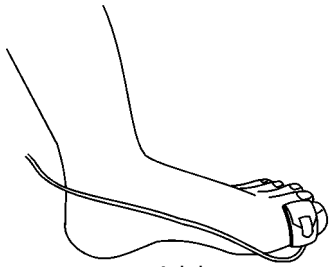


Neonatal/pediatric foot

CATALOG NO. 8836 LARGE



Adult/pediatric finger



Adult toe

4. Position the sensor so that the foam wrap does not extend over the spaces between the fingers or toes. This ensures no light transmission through this space.

WARNING

Treat foam wrap in accordance with hospital protocol for single-patient use. Check site regularly to ensure adequate circulation and proper sensor positioning.

Adhesive Foam Wraps

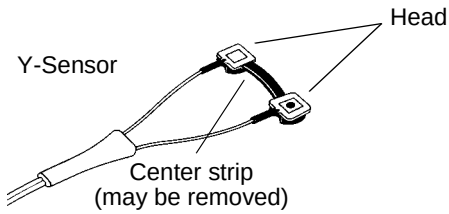
Adhesive foam wraps are for use when applying the Novametrix Y-Sensor™ (catalog No. 8793 or 8791) to adult, pediatric or neonatal patients.

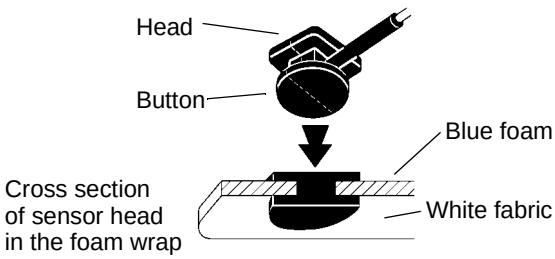
Select a foam wrap based on the patient type:

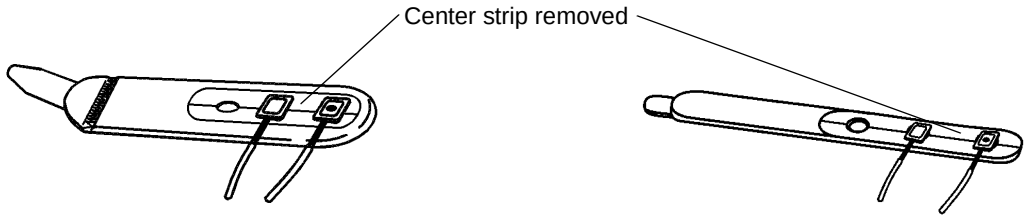
- Catalog No. 6929: Large, adult/pediatric finger, neonatal/pediatric foot or hand
- Catalog No. 6968: Small, neonatal foot or hand, pediatric toe or finger

To use the adhesive foam wrap:

1. With the blue side of the foam wrap facing up, press the buttons on the back of each Y-sensor head through the holes in the foam wrap. The wrap will stretch to fit the buttons. The white side of foam should show two blue circles where the buttons were pushed through.



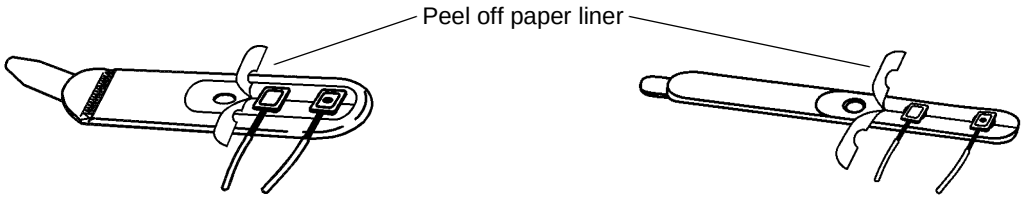




NOTE

If using the first and third holes on the foam wrap it may be necessary to cut the center strip off the Y-sensor.

2. Remove both sides of the release liner.



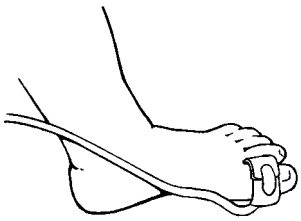
3. Face the blue side of the wrap toward the skin and wrap around the site. If using the neonatal/pediatric foam wrap, Velcro tab may be removed and replaced to allow excess foam to be cut as necessary. Secure with the Velcro® tab.

WARNING

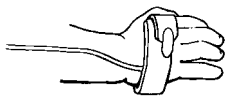
Do not wrap around the limb so tightly that circulation is restricted. Inspect the site often, at least once every four hours, for adequate circulation.

4. *Ensure the sensor heads are directly opposite each other through the tissue.* This prevents the sensor from being placed on a site too thick for proper operation.

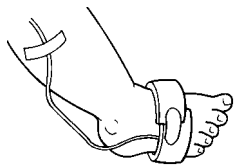
CATALOG NO. 6968 NEONATAL/PEDIATRIC



Pediatric toe

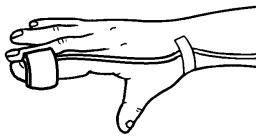


Neonatal hand

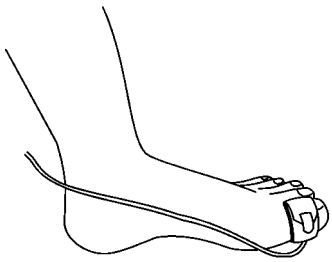


Neonatal/pediatric foot

CATALOG NO. 6929 LARGE



Adult/pediatric finger



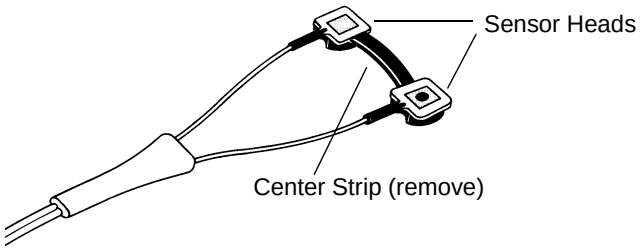
Adult toe

WARNING

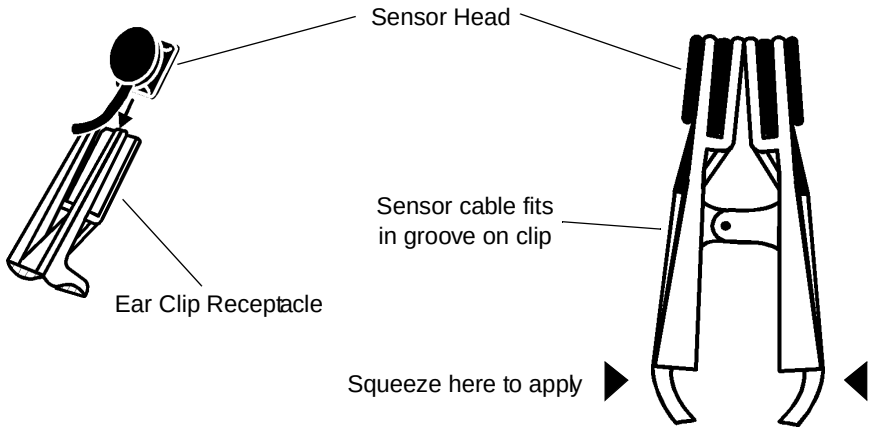
Treat foam wrap in accordance with hospital protocol for single-patient use. Check site regularly to ensure adequate circulation and proper sensor positioning.

Y-Sensor Application using Ear Clip

1. Remove center strip from the Y-Sensor.

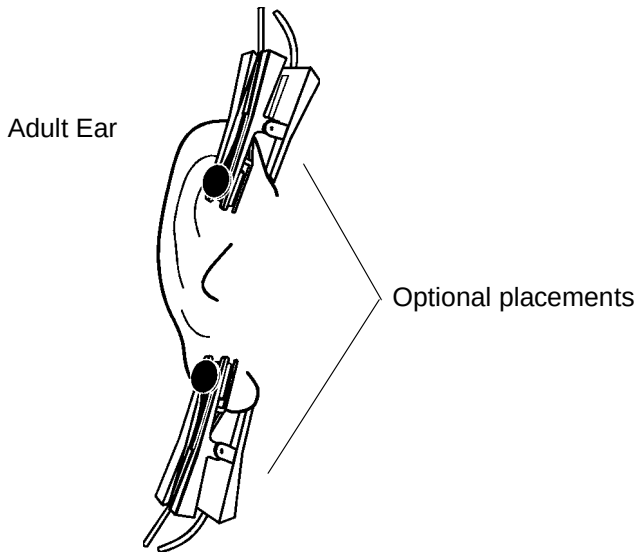


2. Slide each Y-Sensor head into the ear clip‘s receptacles, the heads should face each other.



3. Gently squeeze the end of the ear clip (shown in diagram), and apply the sensor to the patient.

   If a satisfactory reading cannot be obtained, rub the site and/or use adhesive dots for better response. The adhesive dots (PN: 8700-00) included with the ear clips will also help in preventing the ear clip from falling off (e.g. during exercising).



WARNING

Inspect the site often for adequate circulation—at least once every four hours. When applying sensors take note of patient's physiological condition. For example, burn patients may exhibit more sensitivity to heat and pressure and therefore additional consideration such as more frequent site checks may be appropriate.

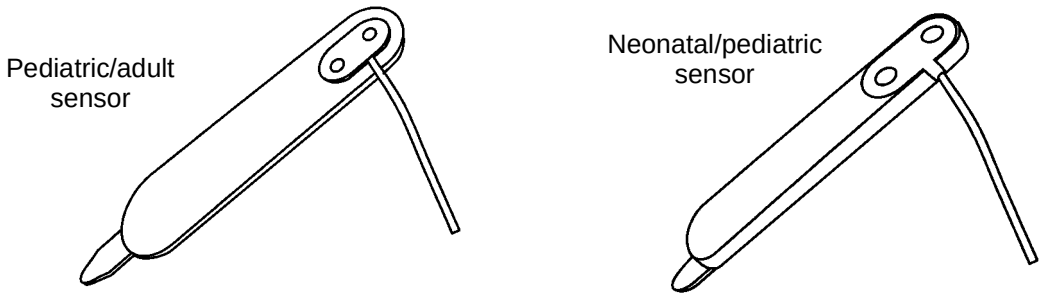
Y-Sensor Quick Check

1. With the Y-Sensor connected to monitor but not applied to patient, position the sensor heads so that they face each other (the red light shines at the detector). Is SpO2 PROBE OFF PT (patient) displayed?
2. Tape the Y-Sensor to your index finger. Does the monitor shows reasonable SpO_2 and pulse rate values?
3. A YES to BOTH #1 and #2 indicates the sensor is OK. Apply the sensor to the patient as instructed above.

Single Patient Use SpO_2 Sensors

Intended Use

The Single Patient Use SpO_2 sensors (Catalog No. 6480 and 6455) can be used when monitoring adult, pediatric or neonatal patients with Novametrix Pulse Oximeters (SuperBright series). These sensors are used with the DB-9 extension cable.



WARNING

Use the Single Patient Use sensor and DB9 extension cable only with Novametrix SuperBright compatible pulse oximeters. Use with any other device may result in equipment damage or patient injury.

CAUTION

These SpO_2 sensors are intended for single patient use. The sensors can be reapplied to various sites on the same patient but should not be used on multiple patients. Do not attempt to clean or disinfect the sensor, as system performance will be compromised.

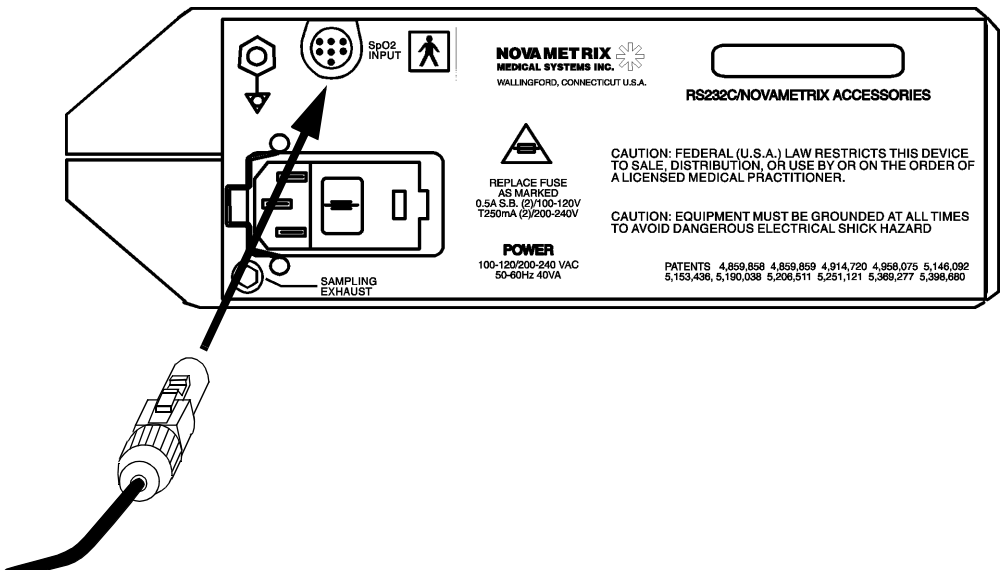
NOTE

The Single Patient Use sensor should be discarded if sensor integrity becomes questionable.

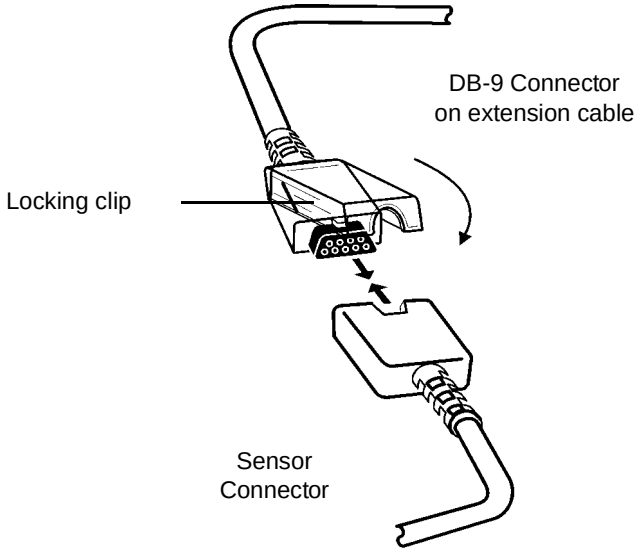
Instructions for Use

1. Connect the DB-9 extension cable to the rear panel conector on the *CO_2SMO*.

SpO2 Input Connector

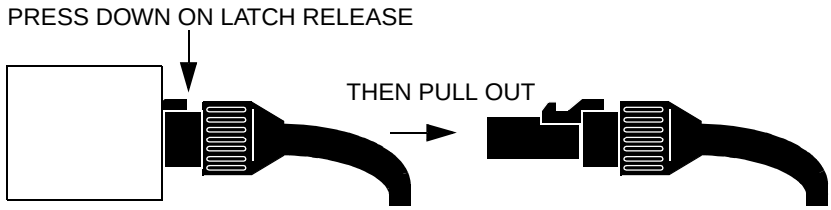

SpO2
INPUT
NOVAMETRIX
MEDICAL SYSTEMS INC.
WALLINGFORD, CONNECTICUT U.S.A.
RS232C/NOVAMETRIX ACCESSORIES
REPLACE FUSE
AS MARKED
0.5A S.B. (2)/100-120V
T250mA (2)/200-240V
CAUTION: FEDERAL (U.S.A.) LAW RESTRICTS THIS DEVICE TO SALE, DISTRIBUTION, OR USE BY OR ON THE ORDER OF A LICENSED MEDICAL PRACTITIONER.
CAUTION: EQUIPMENT MUST BE GROUNDED AT ALL TIMES TO AVOID DANGEROUS ELECTRICAL SHICK HAZARD
POWER
100-120/200-240 VAC
50-60Hz 40VA
PATENTS 4,859,858 4,859,859 4,914,720 4,958,075 5,146,092 5,153,436, 5,190,038 5,206,511 5,251,121 5,369,277 5,398,680
SAMPLING
EXHAUST

2. Press the white connector on the end of the extension cable into the gray connector on the end of the Single Patient Use sensor. Close the locking clip until it snaps around the sensor cable.



3. To disconnect the DB-9 extension cable from the sensor, open the locking clip, grasp the connectors and pull them apart.

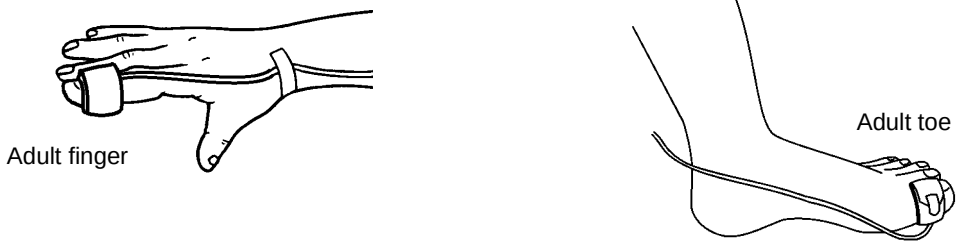
   To disconnect the DB-9 connector from the *CO_2SMO*, press the latch release lever on the extension cable connector and pull the connector straight back away from the monitor. DO NOT twist the connector.



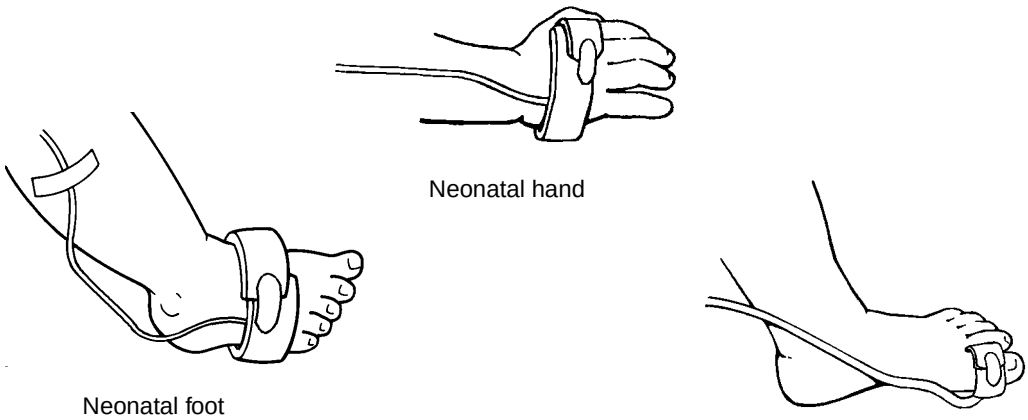
Sensor Application

4. Select the appropriate size sensor based on the patient type.

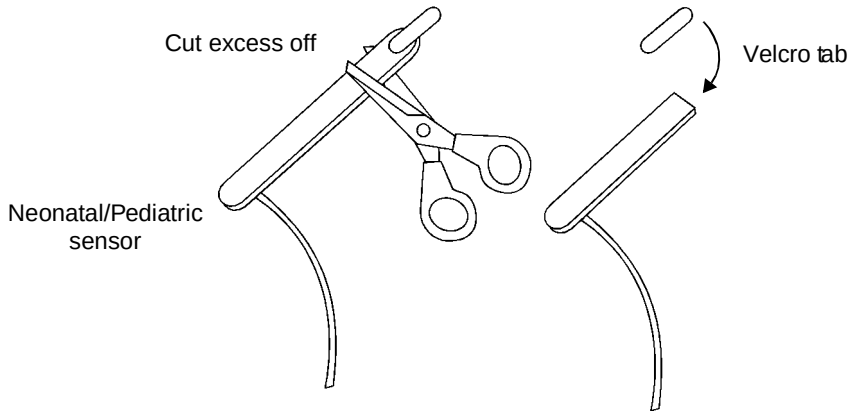
PEDIATRIC/ADULT SENSOR



NEONATAL/PEDIATRIC SENSOR



5. To apply the sensor, place the blue side of the sensor wrap against the skin, wrap it around the site and secure with Velcro® tab. If necessary, cut the excess foam from the neonatal/pediatric sensor before applying the Velcro tab, then reattach the tab and secure the sensor.



Ensure that the sensor heads are positioned directly opposite each other through the tissue. The adhesive dots (Catalog No. 8700) which are included with each sensor can be applied to the sensor before patient application for additional adhesion to the site.

6. For additional support, secure the cable along the limb with tape.

WARNING

Do not wrap the sensor around the limb so tightly that circulation is restricted. Inspect the site often, at least every four hours, for adequate circulation. When applying sensors take note of patient's physiological condition. For example, burn patients may exhibit more sensitivity to heat and pressure and therefore additional consideration such as more frequent site checks may be appropriate.

Single Patient Use SpO_2 Sensor Quick Check

1. With the sensor connected to monitor but not applied to the patient, position the sensor heads so that they face each other (the red light shines at the detector). Is "PROBE OFF PATIENT" displayed?
2. Secure the sensor on your index finger. Does the monitor show reasonable SpO_2 and pulse rate values?
3. A YES to BOTH #1 and #2 indicates that the sensor is OK. Apply the sensor to the patient as instructed above.

   This quick check also tests the functionality of the extension cable.

Section 7 *Monitoring SpO_2 and Pulse Rate*

Once an SpO_2 sensor is connected to the monitor and properly applied to the patient, CO_2SMO displays SpO_2, Pulse Rate, a plethysmographic waveform and a SIGNAL bar that gives a qualitative indication of the strength of the pulsatile signal the monitor is receiving (If necessary, press WAVE FORM to display the plethysmogram and signal bar).

SpO_2 Display Averaging

The Oxygen Saturation value is determined in part by the user selected SpO_2 display averaging. Averaging affects only the numerical display and not the plethysmogram.

A short averaging time provides faster response to changing patient conditions while a longer averaging time helps eliminate the interference from motion or other artifact.

With two-second (2s) averaging, displayed SpO_2 is based on the two most recent seconds of collected saturation data. With eight-second (8s) averaging, displayed SpO_2 is based on the eight most recent seconds of saturation data. All data collected within the sliding 2 or 8 second time period is averaged; the result is displayed as SpO_2.

To change the SpO_2 display averaging:

1. Press the **MENU** key. CO2 OPTIONS appears.
2. Press the **NEXT** key. SYSTEM MENU OPTIONS appears.
3. Press the **AVG** (averaging) key. AVERAGING SELECTIONS appears.
4. Press the **SpO2** key. SELECT SpO2 AVERAGING appears.

   The currently selected averaging time flashes.
5. Press **2s** (two second) or **8s** (eight second) averaging.

   AVERAGING SELECTIONS reappears.
6. Press **RUN** to return to the Main Menu.

Pulse Rate Display Averaging

Pulse Rate is determined by a fixed eight second averaging period.

Pulse "Beep" Volume

CO_2SMO is equipped with an audible pulse beep feature that allows the user to "hear" changes in the patient's SpO_2 and pulse rate. An audible "beep" occurs with each detected pulse beat. The time between beeps indicates the pulse rate.

The pitch of the beep varies with the SpO_2 value. The highest pitched tone sounds while the SpO_2 value is greater or equal to the SpO_2 High Alert limit setting minus 3 percent. The beep's pitch decreases with each one digit drop in SpO_2 below that level. There are thirty-two different tones. If the SpO_2 value drops more than 32 percent below the SpO_2 high alert limit setting, the beep remains at the lowest pitched level.

To vary the pulse beep volume:

1. Press the **MENU** key. CO2 OPTIONS appears.
2. Press the **NEXT** key. SYSTEM OPTIONS appears.
3. Press the **AUDIO** softkey. SET AUDIO FEATURES appears.
4. Press the **PULSE** key. SET PULSE VOLUME appears.

   The current pulse volume setting (0-7) is displayed between the up and down arrows. A setting of 0 turns off the pulse beep feature.
5. Press ↑ or ↓ to increase or decrease the pulse volume setting.
6. Press **RUN** to return to the Main Menu.

Signal Bar

The SIGNAL bar reflects the pulsatile signal strength detected by the SpO_2 sensor. Strong pulsatile signals produce a tall SIGNAL bar, while weak pulsatile signals produce a correspondingly shorter bar. Typical signals are 25-75% of the signal bar height. The SIGNAL bar is shown only in the Plethysmogram display, not in dual waveform mode (If necessary, press WAVE FORM to display the plethysmogram and signal bar).

Plethysmogram Display

CO_2SMO displays a plethysmogram—a representation of the pulsatile waveform as detected by the SpO_2 sensor (If necessary, press WAVE FORM to display the plethysmogram and signal bar). The display is continually updated from left to right. The monitor automatically adjusts the vertical size of the plethysmogram to best fit the display area—maximizing viewability of the waveform. However, this means the waveform gives no indication of pulsitile signal magnitude (Refer to the Signal Bar).

Waveform Autosize

The Waveform Autosize feature can be turned off if the user wants the plethysmogram magnitude to reflect detected signal strength.

NOTE

If the plethysmogram is displayed and Plethysmogram Autosize is set to **OFF**, a **SIZE** key is displayed in the Main Menu.

To turn the Plethysmogram Autosize feature on or off:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Press the **NEXT** key. SpO2 SETUP OPTIONS appears.
3. Press the **SIZE** key. PLETH AUTOSIZE appears.

   The current setting flashes.
4. Press **ON** or **OFF** as desired. SPO2 SETUP OPTIONS reappears.

   ON allows continual automatic adjustment of the magnitude of the plethysmogram. **OFF** allows the user to lock plethysmogram's vertical scaling—making the waveform magnitude reflect relative signal strength.
5. Press **RUN** to return to the Main Menu.

Using the SIZE softkey

With the plethysmogram displayed and Plethysmogram Autosize turned off, a **SIZE** key appears in the Main Menu. During the first thirty seconds after the SpO_2 sensor is applied to the patient, the monitor adjusts the vertical size of the plethysmogram to best fit the display area.

The monitor then "locks" the vertical scaling of the plethysmogram so that subsequent changes in the magnitude of the pulsatile signal cause the plethysmogram to grow smaller or larger—and provide an indication of changes in pulsatile signal strength relative to the "lock" point.

The "lock" point is indicated on the Signal Bar by dots on either side of the bar. Once locked, stronger or weaker signals will still cause the Signal Bar to grow or shrink, but the dots marking the lock point remain in place. These lock points remain fixed until the user presses **SIZE** and a new lock point is determined.

If the magnitude of the patient's pulsatile signal strength changes to the point where the plethysmogram is too small or too large to be of practical value, press the **SIZE** key. The monitor will "unlock" the vertical scaling and Signal Bar lock point, display RESIZING PLETH and allow five seconds for the display to reach an optimal display size, then "re-lock" the Signal Bar and plethysmogram display's vertical scale.

SpO_2 Timers

CO_2SMO ensures that only valid pulsatile signals are processed. Bad or invalid data causes alerts to occur. These alerts are accomplished with the use of SpO_2 Timers including the Display Held Timer, the Special Alert Delay, and the Bad Signal Timer.

Display Held Timer

The Display Held Timer activates if the monitor cannot detect a regular and rhythmic pulsatile signal for periods longer than 10 seconds. While the Display Held Timer is active, NO SAT UPDATE is displayed in the Message Center, and SpO_2 and Pulse Rate displays are not updated—the last valid values are "Held". The timer display indicates how "old" the displayed SpO_2 and Pulse Rate information is.

The Display Held Timer can be activated by:

- excessive motion
- improper sensor placement (INSUFFICIENT LIGHT or PROBE OFF PATIENT messages)
- electrosurgical interference

- ambient Light Interference
- Low (pulsatile) Signal Strength

The SpO_2 and Pulse Rate displays blank out and display "- - -" if the duration of the invalid data exceeds the Special Alert Delay setting. Once started, the Display Held Timer remains active for as long as invalid data is received from the sensor (After 99 seconds the timer display remains at 99).

The Display Held Timer is reset to zero seconds and the timer message disappears as soon as a regular and rhythmic pulsatile signal is detected.

The timer display message can be disabled by the user if desired. In this case, the timer display will not appear but the SpO_2 and Pulse Rate displays will still blank out if the Special Alert Delay is exceeded.

NOTE

The Display Held Timer is set by the factory defaults to Off. The Display Held Timer affects all Timer Displays. See "Special Alert Delay" on page 54 and "Bad Signal Timer" on page 55.

To determine or alter the current setting of the Display Held Timer display:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Press the **NEXT** key. SPO2 SETUP OPTIONS appears.
3. Press the **NEXT** key. SPO2 TIMERS appears.
4. Press **the HELD** key. DISPLAY HELD TIMER appears.

   The current setting flashes.
5. Press **ON** or **OFF** as desired. SPO2 TIMERS reappears.

   ON allows the timer to be displayed in the Message Center.
   OFF prevents the timer from being displayed.
6. Press **RUN** to return to the Main Menu.

Special Alert Delay

The Special Alert Delay alert feature allows the user to adjust the time interval between the occurrence of "special" conditions and the activation of audible and visible alerts.

Special alerts include Low Signal Strength, Light Interference and Insufficient Light. These conditions are usually transitory in nature and allowing the user to vary the delay before alarm activation helps to avoid "nuisance" alarms while still alerting the user to a persistent condition.

An alert message is displayed as soon as a special alert occurs and if the duration of the special alert exceeds the Special Alert Delay setting, the SpO_2 and Pulse Rate displays will blank out and display "- - -", the 🔔 indicator starts to flash and the audible alarm will sound (unless disabled by the user).

The Special Alert Delay also controls the blanking of the SpO_2 and Pulse Rate displays during a NO SAT UPDATE event. Refer to Display Held Timer.

To determine or alter the current setting of the Special Alert Delay:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Press the **NEXT** key. SPO2 SETUP OPTIONS appears.
3. Press the **NEXT** key. SPO2 TIMERS appears.
4. Press **the SPEC** (special) key. SPECIAL ALERT DELAY appears.

The current setting flashes.

5. Press **30s**, **45s**, **60s** or **90s** (seconds) as desired. SPO2 TIMERS reappears.
6. Press **RUN** to return to the Main Menu.

Bad Signal Timer

The Bad Signal Timer feature provides audible (unless disabled by the user) and visible alerts in the event the monitor does not receive valid pulse and saturation data from the sensor (i.e., a regular and rhythmic pulsatile signal) for an extended period of time. Typically, conditions such as *continuous* excessive motion, cardiac arrhythmia, or other physiologic conditions providing *extremely poor plethysmogram signals*, will cause the BAD SIGNAL TIMEOUT message and alerts to activate.

The timer has selectable delay times of 0, 15, 30, or 60 seconds from the monitor's initial detection of the bad signal, to activation of the alerts.*

The Bad Signal Timer feature works in conjunction with the Display Held Timer and Special Alert Delay. For example:

- If the monitor detected and continued to receive bad signals from the sensor (due to excessive motion, etc.), the Display Held Timer would display (if enabled) at 10 seconds. It would continue to count up until it reached the Special Alert Delay setting. At this point the monitor's saturation and pulse rate display values would blank out and display "- - -". The signal bar and plethysmogram will remain visible, allowing evaluation of the patient pulsatile signal.
- Providing the monitor is still receiving bad signals from the sensor, the timer display continues to count up to 99 seconds—after which it remains at 99. Once the user selected (0, 15, 30, or 60 seconds) bad signal delay has elapsed from the time the displays have blanked, the message SPO2 BAD SIGNAL is displayed and the monitor's audible and visible alerts will activate (providing they have not been previously disabled by the user). The signal bar and plethysmogram will remain visible, allowing evaluation of the patient pulsatile signal.
- This alert condition will remain active until CO_2SMO again starts to receive valid plethysmogram data from the sensor—at which point the saturation and pulse rate displays will re-enable, the error message will disappear and the audible and visible alerts will stop.
- If, at any time before the SPO2 BAD SIGNAL message appears, the monitor receives good signals, the timers are reset and no alerts occur.

To determine or alter the current setting of the Bad Signal Timer:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Press the **NEXT** key. SPO2 SETUP OPTIONS appears.
3. Press the **NEXT** key. SPO2 TIMERS appears.
4. Press the **BAD** key. and ALERT ON BAD SIGNAL appears.

   The current setting flashes.
5. Press **0s**, **15s**, **30s**, **60s** as desired. SPO2 TIMERS reappears.

   0s for no delay.
   15s for 15 second delay.
   30s for 30 second delay.
   60s for 60 second delay.
6. Press **RUN** to return to the Main Menu.

*Note, however, that other alerts (Low Signal Strength, Light Interference, Insufficient Light, Probe Off Patient, etc.) may activate prior to the SPO2 BAD SIGNAL. These alerts also serve to notify the user that a potentially adverse situation exists.

IABP Mode

CO_2SMO uses advanced signal processing algorithms to distinguish valid pulsatile signals from signals generated by motion or other artifact. Motion artifact, very common in all but heavily sedated patients, can swamp the true pulsatile signal or distort it enough to produce significant errors in the SpO_2 and Pulse Rate calculations. CO_2SMO's *Validator* algorithms reject distorted plethysmographic signals or those that lack a regular rhythmic pattern. Therefore, only *valid* (i.e., pulsatile) signals are allowed to affect the monitor's SpO_2 and Pulse Rate calculations. Unfortunately, rare conditions exist where the pulsatile waveform truly is distorted and lacks a fixed rhythm—specifically during use of an *Intra-Aortic Balloon Pump* (IABP).

During IABP procedures the pulsatile signal can be massively distorted without affecting the patient's SpO_2. In order to accommodate these IABP procedures (without compromising CO_2SMO's superior artifact rejection algorithm) *IABP Mode* is available. IABP Mode allows the user to turn off the Validator algorithm so that all pulsatile data, including the normally rejected artifact generated by the IABP, are allowed to influence the SpO_2 and Pulse Rate calculations.

WARNING

With IABP Mode turned on, the clinician must exercise prudence in assessing the validity of the SpO_2 and Pulse Rate displays because any motion or other artifact—not just that associated with the IABP—can have a significant affect on the SpO_2 and Pulse Rate calculations.

While in IABP Mode, the displayed Pulse Rate reflects true pulsatile signal—heart rate plus the IABP ratio (Example #1: heart rate = 120 bpm, IABP ratio = 1:1, then displayed Pulse Rate should be 120+(120/1)=240 beats/min. Example #2: heart rate = 120 bpm, IABP ratio = 1:3, then displayed Pulse Rate should be 120+(120/3)=160 beats/min.). Since while in IABP Mode the pulse rate display will be affected by motion or other artifact, the accuracy of the Pulse Rate display can usually be used as an indicator of the quality of the SpO_2 display.)

Making IABP Mode Available

Before the clinician can use IABP Mode, the mode must be made available to the Main Menu (The monitor's factory default settings do not allow use of IABP Mode). Once IABP Mode is available to the Main Menu, a softkey labelled **IABP** appears in the AVERAGING SELECTIONS menu.

To allow IABP Mode to be selected from the Main Menu system:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Press the **NEXT** key. SPO2 SETUP OPTIONS appears.
3. Press the **IABP** key. IABP MODE AVAILABLE ? appears.

   The current setting flashes.
4. Press **YES** or **NO** as desired.

   YES. An **IABP** softkey appears in the AVERAGING SELECTIONS menu.
   NO. IABP Mode cannot be activated from the Main Menu.

NOTE

Once the decision on IABP Mode Main Menu availability is made, that choice will remain in effect, even if the monitor is turned off and on, until changed by the user.

5. SPO2 SETUP OPTIONS reappears. Press **RUN** to return to the Main Menu.

Turning IABP Mode On/Off

Once IABP Mode is made available to the Main Menu (refer to the previous section) IABP Mode can be turned on or off as desired.

To turn IABP MODE on or off:

1. Press the **MENU** key. CO2 OPTIONS appears.
2. Press the **NEXT** key. SYSTEM OPTIONS appears.
3. Press the **AVG** (averaging) key. AVERAGING SELECTIONS appears.
4. Press the **IABP** key. SELECT IABP MODE appears.

   The current setting flashes.
5. Press **ON** or **OFF** as desired.

   ON. IABP Mode is turned on. The message IABP appears below the pulse rate display.
   OFF. IABP Mode is turned off.

NOTE

While availability of IABP Mode to the Main Menu is retained in memory and restored each time the monitor is turned on, CO_2SMO always powers up with IABP Mode turned off. The user must intentionally select IABP Mode from the AVERAGING SELECTIONS menu.

6. AVERAGING SELECTIONS reappears. Press **RUN** to return to the Main Menu.

Using IABP Mode

When IABP Mode is turned on, the message "IABP" appears below the pulse rate display.

WARNING

With IABP Mode turned on, the clinician must exercise prudence in assessing the validity of the SpO_2 and Pulse Rate displays because any motion or other artifact—not just that associated with the IABP—can have a significant affect on the SpO_2 and Pulse Rate calculations.

While in IABP Mode, the displayed Pulse Rate reflects true pulsatile signal—heart rate plus the IABP ratio (Example #1: heart rate = 120 bpm, IABP ratio = 1:1, then displayed Pulse Rate should be 120+(120/1)=240 beats/min. Example #2: heart rate = 120 bpm, IABP ratio = 1:3, then displayed Pulse Rate should be 120+(120/3)=160 beats/min.). Since while in IABP Mode the pulse rate display will be affected by motion or other artifact, the accuracy of the Pulse Rate display can usually be used as an indicator of the quality of the SpO_2 display.)

Even if IABP Mode is on, VERY poor sensor signals activate the Display Held Timer (if enabled).

SpO_2 limit alerts function as usual while IABP Mode is turned on. Pulse Rate limits also function as usual while IABP Mode is turned on.

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Section 8 Alerts

Overview

CO_2SMO provides several alert options.

- Alert limits can be adjusted automatically with the Auto Alerts feature or manually from within the menu system.
- Limit alerts require user action to be reset; they can also be configured to automatically reset.
- Alert limit settings are retained in memory and restored each time the monitor is turned on; the monitor can also be set to power up each time using default settings.
- Audible alerts are delayed 10 seconds from the occurrence of a limit alert; the delay can also be eliminated to allow instant activation.
- Audible alert volume can be adjusted.
- Audible alerts can be temporarily silenced for two minutes.
- Audible alerts can be suppressed altogether via the Audio Off feature. Furthermore, the Audio Off feature can itself be disabled for use in situations where suppressing audible alerts is undesired.
- The Alert Bar stops flashing automatically if the parameter that caused a limit alert returns within its limits or, the Alert Bar can instead be set to continue flashing until the user presses the ALERT RESET key or, the Alert Bar can be turned off altogether.

Limit Alerts

CO_2SMO provides audible and visible limit alerts for $ETCO_2$, Respiratory Rate, SpO_2 and Pulse Rate. Each parameter has separate alert limits.

Limit Alerts are audible and visible signals generated by the CO_2SMO in response to parameter values that violate the Alert Limits.

Alert Limits are the maximum and minimum allowable values for each parameter.

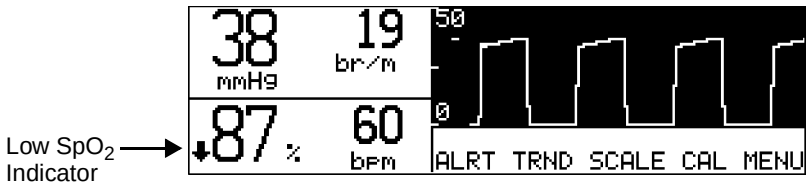
CAUTION

The Limit Alert functions described below assume that the CO_2SMO is using factory default alert parameters. You may experience other results if you are not using the default settings. Refer especially to “Limit Alerts—Delayed/Instant” on page 65.

If $ETCO_2$, Respiratory Rate, SpO_2 or Pulse Rate violates an alert limit setting:

- The red 🔔 (bell-shaped) indicator next to the ALERT RESET key starts to flash.

- An ⬆ or ⬇ (up or down arrow) indicator starts to flash beside the violated parameter's display. The arrow direction indicates a High or Low Limit Alert.



If the parameter returns within its limits before 10 seconds elapse the 🔔 and ⬆ or ⬇ indicators stop flashing.

If the limit alert lasts for longer than 10 second:

- An audible alarm will sound
- The Alert Bar to the right of the display starts to flash
- The violated limit becomes latched

If the parameter returns within limits after 10 seconds of continual alerting:

- The audible alarm will turn off
- The Alert Bar will stop flashing
- The 🔔 and ⬆ or ⬇ indicators continue to flash until the user presses the ALERT RESET key (this allows the user to determine which limit was violated).

Auto Alert Limits

Auto Alerts allow bracketing of the alert limits based on recent patient data.

To set Auto Alert Limits:

1. Press the ALERT RESET **ALRT** key. SET ALERT LIMITS appears.
2. Press the **AUTO** softkey. CO_2SMO sets the alert limits automatically.

   One of the following messages will be briefly displayed.

   - AUTO LIMITS SET. The $ETCO_2$, resp. rate, SpO_2 and pulse rate alert limits have successfully been set to reflect current patient status.
   - NOT ENOUGH DATA TO SET ETCO2 LIMITS. SpO_2 and Pulse Rate alert limits have successfully been set to reflect current patient status, but $ETCO_2$ and Resp. Rate alert limits have not been changed. Ensure the Capnostat is connected to the airway circuit and at least three breaths have been recorded, then press **AUTO** again.
   - NOT ENOUGH DATA TO SET SpO2 LIMITS. $ETCO_2$ and Resp. Rate alert limits have successfully been set to reflect current patient status, but SpO_2 and Pulse Rate alert limits have not been changed. Ensure the SpO_2 sensor is correctly applied to the patient and SpO_2 and pulse rate values are being displayed, then press **AUTO** again.
   - NOT ENOUGH DATA TO SET ETCO2 AND SpO2 LIMITS. Both ETCO2 and SpO2 alert limits have not been changed. Ensure the Capnostat is connected to the airway circuit and at least three breaths have been recorded, also the SpO_2 sensor is correctly applied to the patient and SpO_2 and pulse rate values are being displayed. Then press **AUTO** again.

WARNING

Once the limit values are set, the user should periodically confirm patient status by alternate means and not rely solely on alerts generated when a limit is violated.

3. SET ALERT LIMITS reappears. Press **RUN** to return to the Main Menu.

$ETCO_2$ Auto Alert Limits

The $ETCO_2$ auto alert limits are derived from the average of the three most recent $ETCO_2$ values recorded before **AUTO** was selected. The average then falls into one of two ranges that define the high and low limits. Those ranges are:

$ETCO_2$ Average[A]	High Limit	Low Limit
1 - 40 mmHg	+ 25% of value	- 25% of value
> 40 mmHg	+ 10 mmHg	- 10 mmHg

A.If $ETCO_2$ is displayePa or percent (not mmHg), the limits are based on the equivalent of mmHg.

For example, if the average of the three most recent $ETCO_2$ values recorded before **AUTO** was pushed was 32 mmHg, the upper alert limit is set to 40 (32 + 25% = 32 × 1.25 = 40) and the lower alert limit is set to 24 (32 - 25% = 32 × 0.75 = 24). If the average $ETCO_2$ value was 45 mmHg, the upper limit would be set to 55 (45 + 10 = 55) and the lower limit would be set to 35 (45 - 10 = 35).

Respiratory Rate Auto Alert Limits

The respiratory rate auto alert limits are derived from the average of the three most recent respiratory rate values recorded before **AUTO** was selected. The average then falls into one of three ranges that define the high and low limits. Those ranges are:

Respiration Rate Average	High Limit	Low Limit
1 - 15	+ 7 br/min	- 50% of value
16 - 40	+ 10 br/min	- 7 br/min
> 40	+ 15 br/min	- 10 br/min

For example, if the average of the three most recent respiration rate values recorded before **AUTO** was pushed was 28 br/min, the upper alert limit is set to 38 (28 + 10 = 38) and the lower alert limit is set to 21 (28 - 7 = 21). If the average respiratory rate is 12 br/min, the upper limit would be set to 19 (12 + 7 = 19) and the lower limit would be set to 6 (12 - 50% = 12 × 0.50 = 6).

SpO_2 Auto Alert Limits

The SpO_2 high auto alert limit is set to 5 more than the SpO_2 value displayed when the **AUTO** was pressed (maximum setting =100). The low auto alert limit is set to 5 less than the SpO_2 value displayed when **AUTO** was pressed. (minimum setting = 50).

For example, if the SpO_2=98% when **AUTO** is pushed, the system will set the upper alert limit to 100 (98+5=103 with max of 100) and the lower alert limit to 93 (98-5=93).

Pulse Rate Auto Alert Limits

The pulse rate high auto alert limit is set at 25% more than, and the low auto alert limit is 25% less than, the pulse rate value that was displayed before **AUTO** was selected (maximum = 249 and minimum = 30).

For example, if the pulse rate=72 when **AUTO** is pushed, the system will set the upper alert limit to 90 (72+25%=72×1.25=90) and the lower alert to 54 (72-25%= 72×0.75=54).

Setting Alert Limits Manually

The user can manually adjust alert limits.

CAUTION

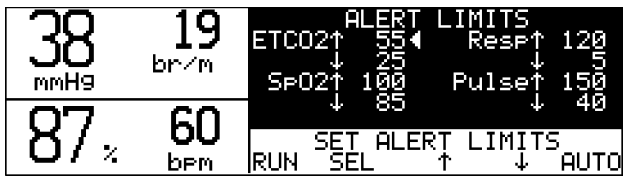
Care should be exercised to ensure clinically reasonable alert limit settings are selected. Novametrix does not recommend the setting of limit values to such a wide span as to effectively render the alert limit feature useless. Once the limit values are properly set, the user should periodically confirm patient status by alternate means and not rely solely on alerts generated when a limit is violated.

Alert limit adjustment ranges are:

- $ETCO_2$ - High 100-5, Low 95-0
- Respiratory Rate - High 150-5, Low 145-0
- Respiratory Rate alerts can be turned off by setting the High limit above 150 or the Low limit below 0. If the Respiratory Rate limits are off, the limits display OFF and no Respiratory Rate limit alerts are generated.
- SpO2 - High 100-55, Low 95-50
- Pulse Rate - High 249-35, Low 244-30
- Pulse Rate alerts can be turned off by setting High limit above 249 or the Low limit below 30. If the Pulse Rate limits are off, the limits display OFF and no Pulse Rate limit alerts are generated.

To manually set the alert limits:

1. Press the **ALRT** key. SET ALERT LIMITS appears.



2. Press **SEL** (select) to move "◀" to the limit to be changed.
3. Press ↑ or ↓ to increase or decrease the selected limit.

Press and release the arrow keys to change the limit value up or down by one.
Press and hold the arrow keys to make the value change more rapidly.

NOTE

CO_2SMO will not allow a parameter's high and low alert limits to be set to within 5 digits of each other. For example, using default values, if the lower Respiratory Rate limit is increased to 116, the upper limit will change from 120 to 121 in order to maintain the 5 digit difference between limits.

4. Once all limits are set as desired, press **RUN**.

Alert Volume

The volume of the monitor's audible alert is user adjustable. The alert volume feature cannot be used to eliminate audible alerts because the alert is still audible at its lowest setting. Use the Two Minute Silence or Audio features to silence audible alerts. See "AUDIO Key" on page 7.

To vary the audible alert volume:

1. Press the **MENU** key. CO2 OPTIONS appears.
2. Press the **NEXT** key. SYSTEM OPTIONS appears.
3. Press the **AUDIO** softkey. SET AUDIO FEATURES appears.
4. Press the **ALRT** key. ALERT VOLUME appears.

   An audible tone sounds and the current alert volume setting (1-7) is displayed between the up and down arrows.
5. Press ↑ or ↓ to increase or decrease the alert volume setting.
6. Press **RUN** to return to the Main Menu.

Audio Mute

In situations where preventing the occurrence of audible alarms by use of the Audio Off feature is not desired, the monitor can be set to disallow use of Audio Off.

Once the monitor is set to disallow use of Audio Off, AUDIO OFF DISABLED is briefly displayed in the Message Center each time the user tries to enable Audio Off.

NOTE

Unlike Audio Off, the Two Minute Silence feature, which temporarily silences the audible alarms for two minutes and then reactivates them, is a separate feature and is not affected by the status of Audio Mute feature.

To enable or disable the monitor's ability to permanently silence the audible alarms:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS is displayed.
2. Repeatedly press the **NEXT** key until ALERT OPTIONS 1 appears.

3. Press **MUTE** and ALLOW AUDIO OFF appears.

   The current setting flashes.

4. Press **YES** or **NO** as desired.

   YES. The user can use Audio Off to permanently silence audible alerts.
   NO. The user cannot use Audio Off. AUDIO OFF DISABLED is displayed instead.

NOTE

Once the decision to allow or disallow the user to use Audio Off is made, that choice remains in effect, even if the monitor is turned off and on, until changed by the user.

5. ALERT OPTIONS 1 reappears. Press **RUN** to return to the Main Menu.

Limit Alerts—Latched/Unlatched

Alerts caused by parameters violating alert limit settings are normally "Latched". Once a latched alert is active for 10 seconds, even if the parameter then returns within its limits, the ⬆ or ⬇ indicator and the 🔔 indicator continue to flash until the user presses the ALERT RESET key. This indicates which parameter caused the alert.

CO_2SMO also supports "Unlatched" alerts that automatically stop the flashing of the ⬆ or ⬇ and 🔔 indicators as soon as the alerting parameter returns within its limits. The user does not have to press the ALERT RESET key when unlatched alerts are in use.

To select Latched or Unlatched alerts:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS is displayed.
2. Repeatedly press the **NEXT** key until ALERT OPTIONS 1 appears.
3. Press **LATCH** and ALERTS LATCHED appears.

   The current setting flashes.

4. Press **YES** or **NO** as desired.

   YES provides latched alerts that require the user to press the ALERT RESET key to clear them.
   NO provides unlatched alerts that reset automatically without user intervention.

NOTE

Once the choice of Latched or Unlatched alerts is made, that choice will remain in effect, even if the monitor is turned off and on, until changed by the user.

5. ALERT OPTIONS 1 reappears**.** Press **RUN** to return to the Main Menu.

Alert Limit Settings—Retained/Defaults

When CO_2SMO is turned on, it restores the (Retained) alert limit settings that were in effect when the monitor was last turned off. However, the monitor can be configured to use its default alert limit values at each power up instead.

To use Retained or Default alert limit settings at power up:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS is displayed.
2. Repeatedly press the **NEXT** key until ALERT OPTIONS 1 appears.
3. Press **DFLT** (default) and RETAIN ALERT LIMITS appears.

   The current setting flashes.
4. Press **YES** or **NO** as desired.

   YES. CO_2SMO powers up using the alert limit settings from the previous use.
   NO. At power up, uses default alert limits: $ETCO_2$ 55-25, Respiratory Rate 120-5, SpO_2 100-85, and Pulse Rate 150-40.

NOTE

Once the choice of Retained or Default alert limit settings is made, that choice will remain in effect, even if the monitor is turned off and on, until changed by the user.

5. ALERT OPTIONS 1 reappears. Press **RUN** to return to the Main Menu.

Limit Alerts—Delayed/Instant

When a parameter violates an alert limit, the ⬆ or ⬇ limit display and the 🔔 indicator start to flash immediately, but the audible alarm and Alert Bar (if enabled) are delayed 10 seconds. This delay helps avoid "nuisance" alarms because if during that first ten seconds the parameter returns within its limits, the alert is cancelled.

The 10 second audible and Alert Bar delay can be eliminated if the user desires the monitor activate audible and Alert Bar alerts as soon as an alert limit is violated. Eliminating the delay also has the effect of latching the alert as soon as it occurs. See "Limit Alerts—Latched/Unlatched" on page 64.

To select or eliminate the 10 second audible and Alert Bar delay for limit alerts:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS is displayed.
2. Repeatedly press the **NEXT** key until ALERT OPTIONS 2 appears.
3. Press **DELAY** and 10 SEC LIMIT ALERT DELAY appears.

   The current setting flashes.
4. Press **YES** or **NO** as desired.

   YES. Audible and Alert Bar alerts for violated alert limits are delayed 10 seconds.
   NO. Audible and Alert Bar alerts occur as soon as an alert limit is violated.

CAUTION

Once the Alert Delay setting is selected, that choice remains in effect, even if the monitor is turned off and on, until changed by the user.

5. ALERT OPTIONS 2 reappears. Press **RUN** to return to the Main Menu.

Alert Bar—Latched/Unlatched/Off

The Alert Bar to the right of the monitor display can be set to operate in three different modes. The Alert Bar can be Latched, Unlatched, or turned off altogether.

A "Latched" Alert Bar starts to flash as soon as a limit alert occurs. If the alerting parameter returns within its limits before 10 seconds elapse, the Alert Bar turns off. If the alert condition lasts for more than 10 seconds, the flashing Alert Bar becomes "latched" and will continue to flash, even if the alerting parameter returns within its limits, until the user presses the ALERT RESET key.*

An "Unlatched" Alert Bar starts flashing 10 seconds after an alert limit violation occurs and turns off as soon as the alerting parameter returns within its limits, regardless of the duration of the alert.

The Alert Bar will not flash under any condition if it has been turned "Off".

NOTE

The red 🔔 (bell shaped) indicator to the left of the ALERT RESET key will always flash whenever a limit alert occurs. Unlike the Alert Bar, 🔔 cannot be turned off.

To turn the Alert Bar on (latched or unlatched) or off:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS is displayed.
2. Repeatedly press the **NEXT** key until ALERT OPTIONS 2 appears.
3. Press **BAR** and ALERT BAR LATCHED appears.

   The current setting flashes.
4. Press **YES** or **NO** or **OFF** as desired.

   YES. Alert Bar starts to flash as soon as a limit alert occurs.
   NO. Alert Bar starts flashing 10 seconds after an alert limit violation occurs.
   OFF. Alert Bar will not flash under any condition.

NOTE

Once the Alert Bar setting is selected, that choice remains in effect, even if the monitor is turned off and on, until changed by the user.

5. ALERT OPTIONS 2 reappears. Press **RUN** to return to the Main Menu.

*However, if Unlatched Alerts are selected (See "Limit Alerts—Latched/Unlatched" on page 64), the Alert Bar will turn off once the alerting parameter returns within its limits.

Section 9 Trend Memory Display

Overview

CO_2SMO maintains trend information for $ETCO_2$, Respiratory Rate, SpO_2 and Pulse Rate. Trend memory is continually and automatically updated. Trend memory can hold up to 24 hours of data. The data is battery-backed, so turning the monitor off and on does not destroy or erase trend memory contents. Trend memory features include:

- Graphical trend memory displays are user selectable. Any 12 hour, 8 hour, 2 hour, or 30 minute portion of trend data can be viewed on-screen in graphical format.
- $ETCO_2$ only, $ETCO_2$ and Respiratory Rate, SpO_2 only, and, SpO_2 and Pulse Rate graphical displays are available.
- Graphical display scales are user selectable.
- Histogram trend memory displays are user selectable. Any 12 hour, 8 hour, 2 hour, or 30 minute portion of trend data can be viewed on-screen in histogram format.
- User selected "Events" can be marked and stored in trend memory. These events appear on-screen when viewing the graphical trend displays.
- Trend memory data in graphical and histogram formats can be output to a printer.
- The user can erase stored trend memory at any time via the trend menus.

NOTE

CO_2SMO continues patient monitoring while trends are displayed. Any latched alert that occurs while viewing trend data causes the Main Menu to reappear. Also, if no keys are pressed for 5 minutes, the Main Menu replaces the trend display.

Graphical Trend Display

To display trend memory:

1. Press the **TRND** key. DRAWING TREND PLEASE WAIT is briefly displayed.

   The most recent 12 hours of $ETCO_2$ or SpO_2 data is then graphically displayed.

NOTE

If the capnogram or dual waveform is displayed when **TRND** is pressed, an $ETCO_2$ trend is drawn: If the plethysmogram waveform is displayed, an SpO_2 trend is drawn.

Press the WAVE FORM key to switch between $ETCO_2$ (and respiratory rate) and SpO_2 (and pulse rate) trend displays.

New trend data is continually collected. The display is redrawn each time you (exit and) enter the trend display mode. New data enters the graph from the right—pushing older already displayed data towards the left (If less than 12 hours of data have been collected, the graph will be shortened accordingly).

Dotted vertical lines indicate times when the monitor was turned off.

The flashing dashed vertical line in the trend is called the cursor.

1a. Press the **<-** (arrow left) key to move the cursor towards older data.

1b. Press the **->** (arrow right) key to move the cursor towards more recent data.

Information displayed in the status line above the graph is specific to the data at the cursor location. The status line includes the following information:

- The date and time the data at the cursor was stored in trend memory. The time is stored in 24 hour format. (e.g., 13:30:00 = 1:30 p.m.)
- For an $ETCO_2$ trend: the $ETCO_2$ (E), Inspired CO_2 (I), and Respiratory Rate (R) values at the time the data was stored.
- For an SpO_2 trend: the SpO_2 (S) and Pulse Rate (P) values at the time the data was stored.
- If a trend "Event" was marked at the time indicated by the cursor, an "E" appears in the right corner of the status line. This space is blank if no event was marked.

2. Move the cursor by pressing the <- or -> (arrow keys) to the desired time.
3. Press the **EXPAND** softkey.

   Successive presses of the **EXPAND** key cause the 8 hour, 2 hour and 30 minute trends to be displayed. Press **EXPAND** again to return to the 12 hour trend display.
4. Use the arrow keys to fine tune the cursor to the desired location in the trend.
5. Press the **RUN** key to return to the Main Menu.

Dual Trend Displays

When the **TRND** key is pushed, the $ETCO_2$ data is displayed if the Capnogram or dual waveform display is running, or SpO_2 data is displayed if the Plethysmogram was running. CO_2SMO will display both $ETCO_2$ and Respiratory Rate or SpO_2 and Pulse Rate trend data simultaneously if this was chosen previously by selecting dual trend displays.

To select dual trend displays:

1. Press the **TRND** softkey. Wait for the trend to be displayed.
2. Press the **NEXT** key. TREND OPTIONS appears.
3. Press **VIEW**. TREND VIEW appears.
4. Press **DUAL** or **ETCO2** (if $ETCO_2$ displayed) or **SpO2** (if SpO_2 displayed) as desired.

   Press **DUAL** to display both $ETCO_2$ and Respiratory Rate or SpO_2 and Pulse Rate trends.
   Press **ETCO2** to display only $ETCO_2$ trend data.
   Press **SpO2** to display only SpO_2 trend data.

WARNING

When the dual trend display is selected the monitor will retain this selection even when the trend display is exited and the monitor is turned off.

$ETCO_2$ and Respiratory Rate Trend Display Scales

The $ETCO_2$ only and $ETCO_2$ and Respiratory Rate trend display scales can be changed.

To change the $ETCO_2$ and/or Respiratory Rate graphical trend display scales:

1. Press the **TRND** key. Wait for the $ETCO_2$ trend to be displayed.

   (If necessary, press the WAVE FORM key to ensure the $ETCO_2$ trend is displayed.)

2. Press the **NEXT** key. TREND OPTIONS appears.
3. Press **VIEW**. TREND VIEW appears.
4. Press **SCAL** (scale). TREND SCALE appears.
5. Press **CO2** or **RESP** as desired.

   Press **CO2** to change the $ETCO_2$ trend display scale.
   Press **RESP** to change the Respiratory Rate display scale.

6. Press **HALF** or **FULL** as desired.

   HALF. Selects 0-50 mmHg for $ETCO_2$ or 0-75 br./min for Respiratory Rate.
   FULL. Selects 0-100 mmHg for $ETCO_2$ or 0-150 br./min for Respiratory Rate.
   The selected parameter is retained in memory even when the monitor is turned off.

7. Press **PREV** as necessary to return to the base trend display.

Dual SpO_2 and Pulse Rate Trend Display Scales

The dual SpO_2 and Pulse Rate trend display scales (but not the SpO_2 only trend display scale) can be changed.

To change the Dual SpO_2 and/or Pulse Rate graphical trend display scales:

1. Press the **TRND** key. Wait for the SpO_2 trend to be displayed.

   (If necessary, press the WAVE FORM key to ensure the SpO_2 trend is displayed.)

2. Press the **NEXT** key. TREND OPTIONS appears.
3. Press **VIEW**. TREND VIEW appears.
4. Press **DUAL**. The dual trend appears and TREND OPTIONS is displayed (skip if DUAL is already selected).
5. Press **VIEW**. TREND VIEW appears (skip if DUAL is already selected).
6. Press **SCAL** (scale). TREND SCALE appears.
7. Press **SpO2** or **PULSE** as desired.

   Press **SpO2** to change the SpO_2 trend display scale.
   Press **PULSE** to change the Pulse Rate display scale.

8. Press **HALF** or **FULL** as desired.

   HALF. Selects 80-100 % for SpO_2 or 50-150 beats/min for Pulse Rate.
   FULL. Selects 60-100 % for SpO_2 or 50-250 beats/min for Pulse Rate.

9. Press **PREV** as necessary to return to the base trend display.

   These settings are retained even when the monitor is turned off.

Histogram Trend Display

Histogram displays provide a neatly tabulated and easily interpreted summary of $ETCO_2$ and Respiratory Rate, or, SpO_2 and Pulse Rate trend memory data.

CO_2SMO's histogram display reflects the currently selected graphical trend type and expansion setting. For example, if the graphic trend display is set to an $ETCO_2$ 12 hour display, the resulting histogram reflects that 12 hours of $ETCO_2$ and Respiratory Rate information. If the graphic display is set to an SpO_2 30 minute display, the resulting histogram reflects that 30 minutes of SpO_2 and Pulse Rate information.

Histogram displays reflect only active monitoring time, the time the Capnostat spends on the Zero and Reference Cells is NOT reflected in the histogram display; likewise, SpO_2 sensor non-monitoring time, such as SpO2 PROBE OFF PT is NOT reflected in the histogram display.

To activate a histogram trend display:

1. Press the **TRND** softkey. Wait for the trend to be displayed.
2. Move the cursor by pressing the **<-** or **->** (arrow keys) to the desired time.
3. Press the **EXPAND** softkey to select the desired trend duration.
4. Press the **NEXT** key. TREND OPTIONS appears.
5. Press the **VIEW** key. TREND VIEW appears.
6. Press the **HIST** (histogram) key to display the histogram.

The top line of the histogram display shows the start and stop dates and times (in 24 hour format) used to tabulate the data.

$ETCO_2$ data (or SpO_2 data) is tabulated on the left side of the display and Respiratory Rate data (or Pulse Rate data) is displayed on the right half. Data for each parameter is tabulated into six categories. Each category represents a range of possible values. For each category, a bar graph is drawn showing the percentage of the total time the parameter was within the category. To the right of the bar graphs are numerical tabulations also showing how long the parameter was within that category.

Trend Data Compression

Data is stored into trend memory every eight seconds.

CO_2SMO can display any 12 hour, 8 hour, 2 hour, or 30 minute portion of its 24 hour trend memory. Since the size of the trend display is a fixed width, the monitor must compress the trend data to fit onto the display—the more data present, the more it must be compressed to fit onto the display. The CO_2SMO trend display is approximately 200 pixels (picture-element) wide. Each horizontal pixel (data point) is equivalent to the following times:

1 data point per 8 seconds in a 30 minute trend
1 data point per 32 seconds in a 2 hour trend
1 data point per 128 seconds (approx. 2 minutes) in an 8 hour trend
1 data point per 192 seconds (approx. 3 minutes) in an 12 hour trend

The monitor determines the trend duration and compresses that amount of data to fit the screen—older data to the left, the most recent to the right.

Because of data compression, data at any horizontal pixel may look like a vertical bar.

For CO_2, the upper extent of the bar represents the maximum $ETCO_2$ value and the bottom of the bar the maximum Inspired CO_2 value stored during that particular compression period. The $ETCO_2$ value displayed above the graph represents the maximum $ETCO_2$ value stored over the compression period.

For Respiratory Rate, SpO_2, and Pulse Rate, the upper extent of the bar represents the maximum value and the bottom of the bar the minimum value stored during that particular compression period. The value displayed above the graph represents the minimum value stored over the compression period.

Erase Trend Memory

Trend information is retained in memory even if CO_2SMO is turned off.

Each time the monitor is turned on the message ERASE STORED TREND ? is displayed. The user can select **YES** to erase the contents of trend memory or press **NO** to keep the previously stored trend data intact. If trend information is not erased at power up, new data will be appended to the old data already in memory. Additionally, the user can, at any time, enter the trend menu and erase stored trend information.

To erase stored trend information from within the trend menus:

1. Press the **TRND** key. Wait for the trend to be displayed.
2. Press the **NEXT** key. TREND OPTIONS appears.
3. Press the **ERASE** key. ERASE STORED TRENDS? appears.
4. Press **YES** or NO as desired.

   YES. Erase stored trend memory data. TRENDS ERASED is briefly displayed.
   NO. Keep stored trend memory data intact. TRENDS RETAINED is briefly displayed.

Trend Print

If PRINTER INTERFACE is selected in the MONITOR OPTIONS 2 portion of the menu system, a **PRNT** key is displayed in the TREND OPTIONS menu.

Press the **PRNT** key (after connecting the selected printer and readying for printing) and the displayed trend duration is graphically printed along with a histogram covering the same time frame.

See “Using a Printer” on page 85.

Trend and NOVACARD Memory Module

If NOVACARD INTERFACE is selected in the MONITOR OPTIONS 2 portion of the menu system, a **CARD** key is displayed in the TREND OPTIONS menu.

Press the **CARD** key (after connecting the NOVACARD MEMORY MODULE and installing a NOVACARD) and the NOVACARD MENU will appear. From this menu trend data can be stored to the memory card, patient ID can be entered or changed, or the NOVACARD can be erased.

See “NOVACARD Memory Module User’s Manual” for more information.

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Section 10 Miscellaneous Features

Keyclick Volume

CO_2SMO can respond to each key press with an audible tone, a "keyclick", assuring the user that the monitor recognized a key was pressed.

To alter the keyclick volume;

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Repeatedly press the **NEXT** key until MONITOR OPTIONS 1 appears.
3. Press **KCLK** (keyclick). KEYCLICK VOLUME appears.
   The current keyclick volume setting (0-7) is displayed between the up and down arrows. A "0" setting means the keyclick feature is turned off.
4. Press ↑ or ↓ to increase or decrease the keyclick volume setting.
   Each key press will cause a keyclick tone to sound.
5. Press **RUN** to return to the Main Menu.

Display Brightness

CO_2SMO has two user selectable display brightness settings.

To select a display brightness setting;

1. Press the **MENU** key. CO2 OPTIONS appears.
2. Press the **NEXT** key. SYSTEM OPTIONS appears.
3. Press the **LITE** key to switch the backlight between its bright and dim settings.
4. Press **RUN** to return to the Main Menu.

Display Colors

The default CO_2SMO display (white text on a blue background and a blue wave over a white background) can be changed. This display colors feature (coupled with the bright and dim backlight settings) allows CO_2SMO to provide a very visible display over a wide range of lighting conditions.

To change the display colors;

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Repeatedly press the **NEXT** key until MONITOR OPTIONS 1 appears.

3. Press **DISP** (display) and the display colors are inverted.

   The two display modes are:
   White text on blue background with a blue wave on white background (default), and
   blue text on a white background with a white wave on a blue background.

4. When the display is as desired, press **RUN** to return to the Main Menu.

Setting the Clock/Calendar

CO_2SMO contains a clock/calendar feature that operates even when the monitor is turned off. This feature allows CO_2SMO to "time stamp" trend data as well as data that is output to external devices such as printers.

Unlike other monitor settings, the clock/calendar is not reset by the power-up-with-Alert-Reset-key feature. The clock/calendar must be reset manually.

To view/alter the current time and date setting;

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Repeatedly press the **NEXT** key until MONITOR OPTIONS 2 appears.
3. Press **CLOCK** and the clock/calendar setup menu appears.
   The current hour setting is flashing.
4. Each press of the **SEL** (select) key selects a new item to highlight (flash).
5. Press ↑ or ↓ to increase or decrease the setting of the highlighted item.
6. When the time and date are correct, press **SET**. MONITOR OPTIONS 2 appears.
7. Press **RUN** to return to the Main Menu.

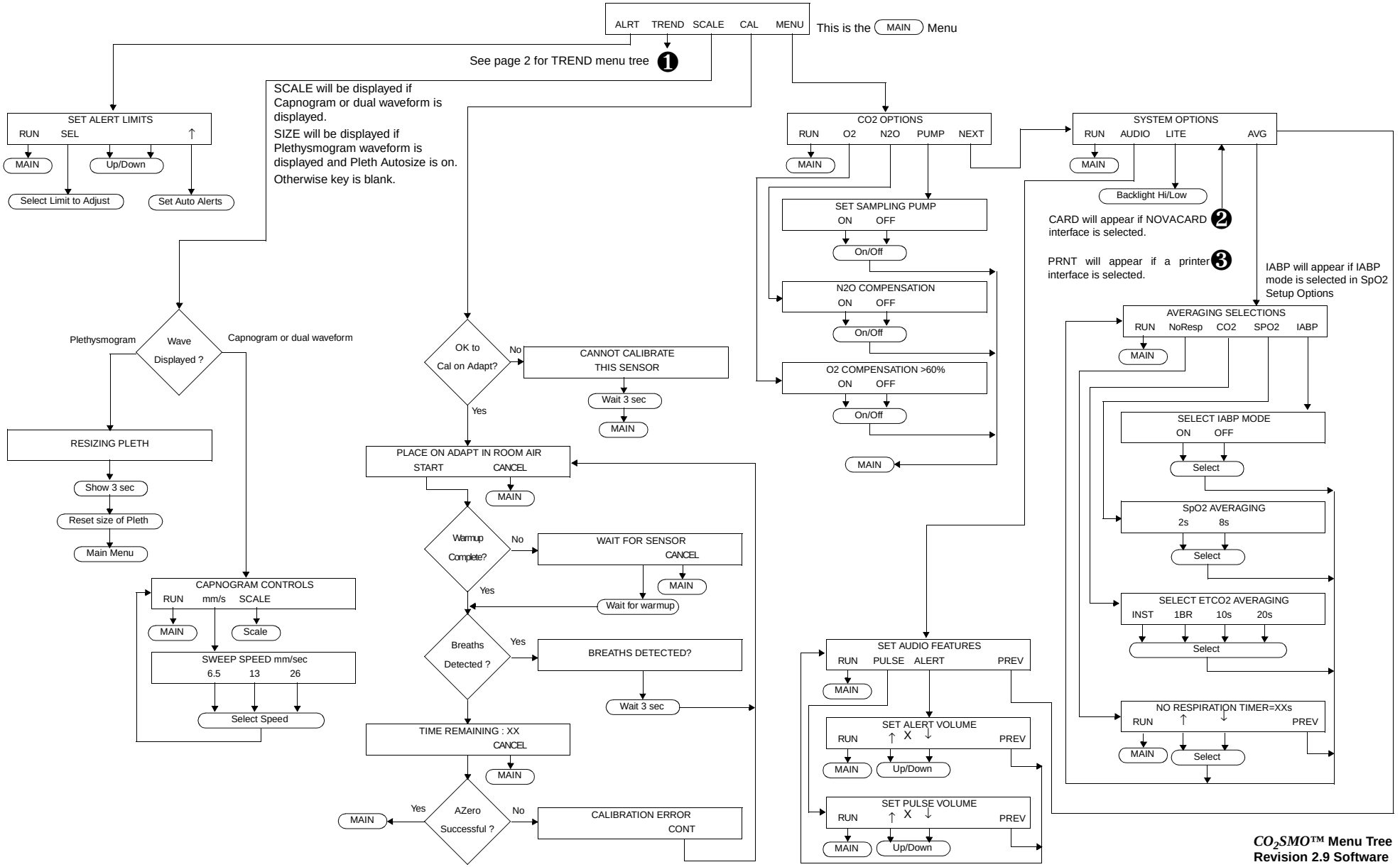
Display Monitor Software Revision Level

To check the revision level and date of CO_2SMO's system software:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Repeatedly press the **NEXT** key until MONITOR OPTIONS 1 appears.
3. Press the **VER#** (version) softkey. The software version number appears.
4. Press the **NEXT** key. The date of the software version appears.
5. Press the **NEXT** key. MONITOR OPTIONS 1 appears.
6. Press **RUN** to return to the Main Menu.

Section 11 *Menu Tree*

The menu flow diagrams of the *CO_2SMO* are listed in the following pages, each menu is shown with its associated softkeys.



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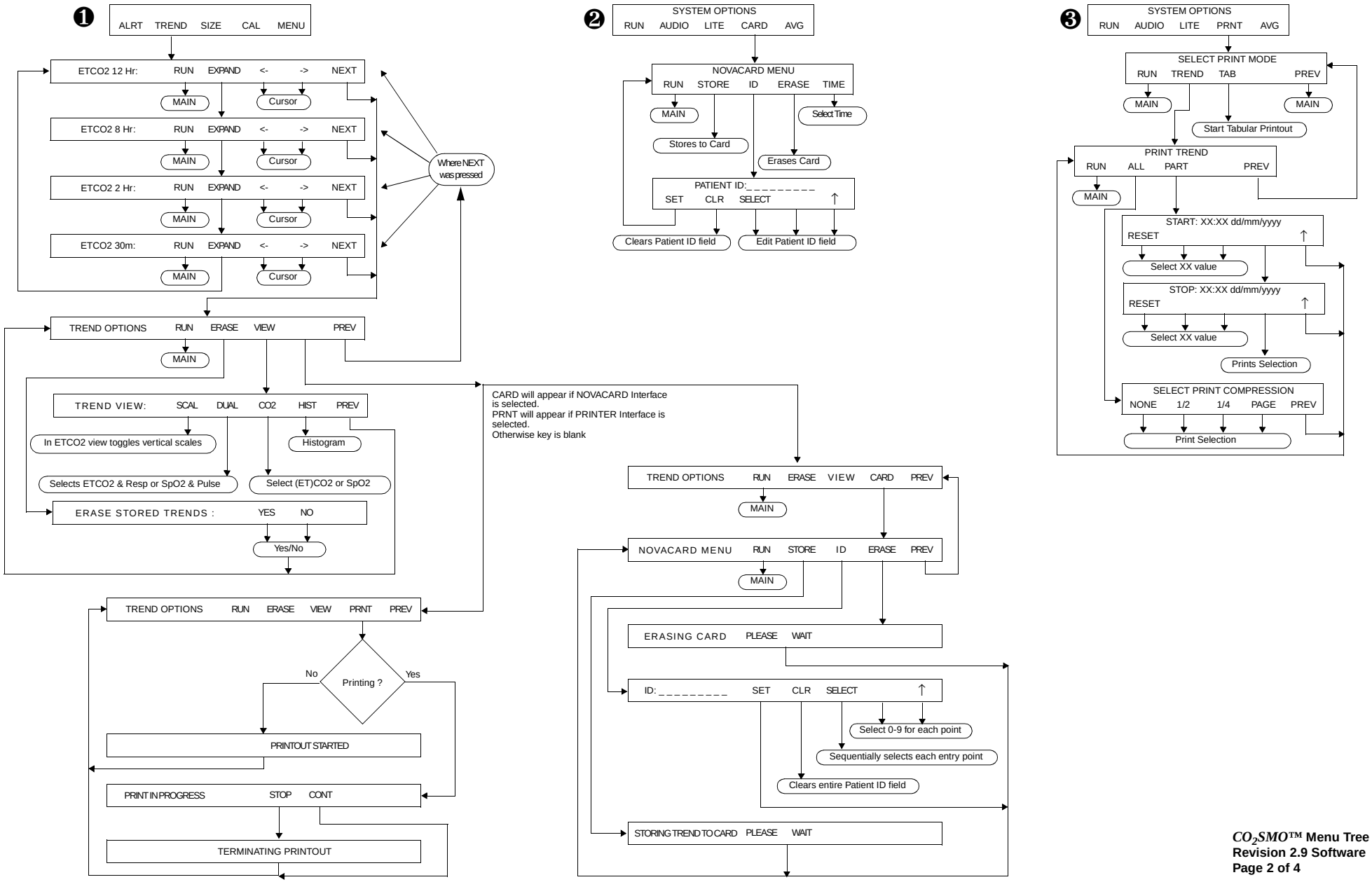

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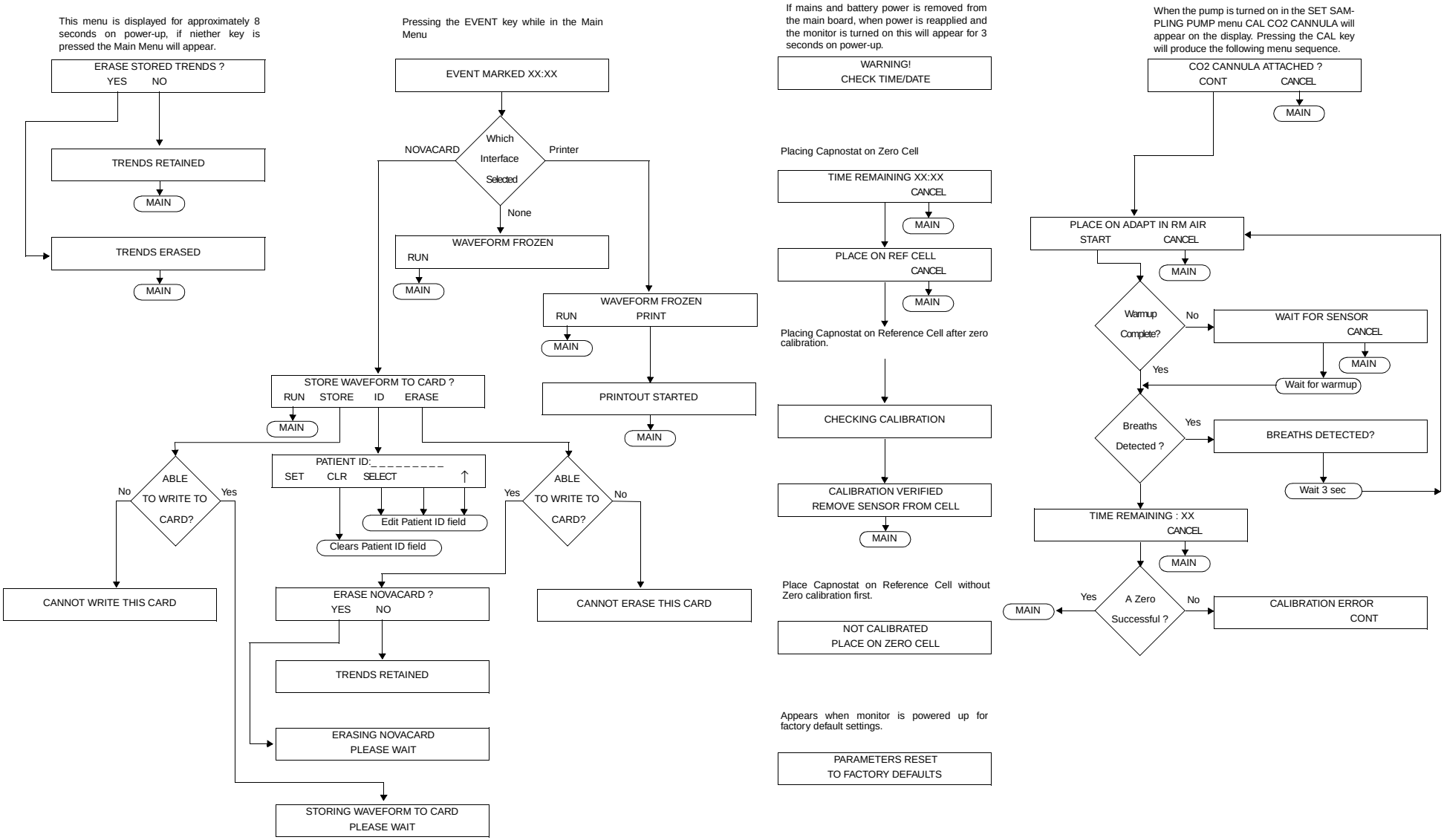
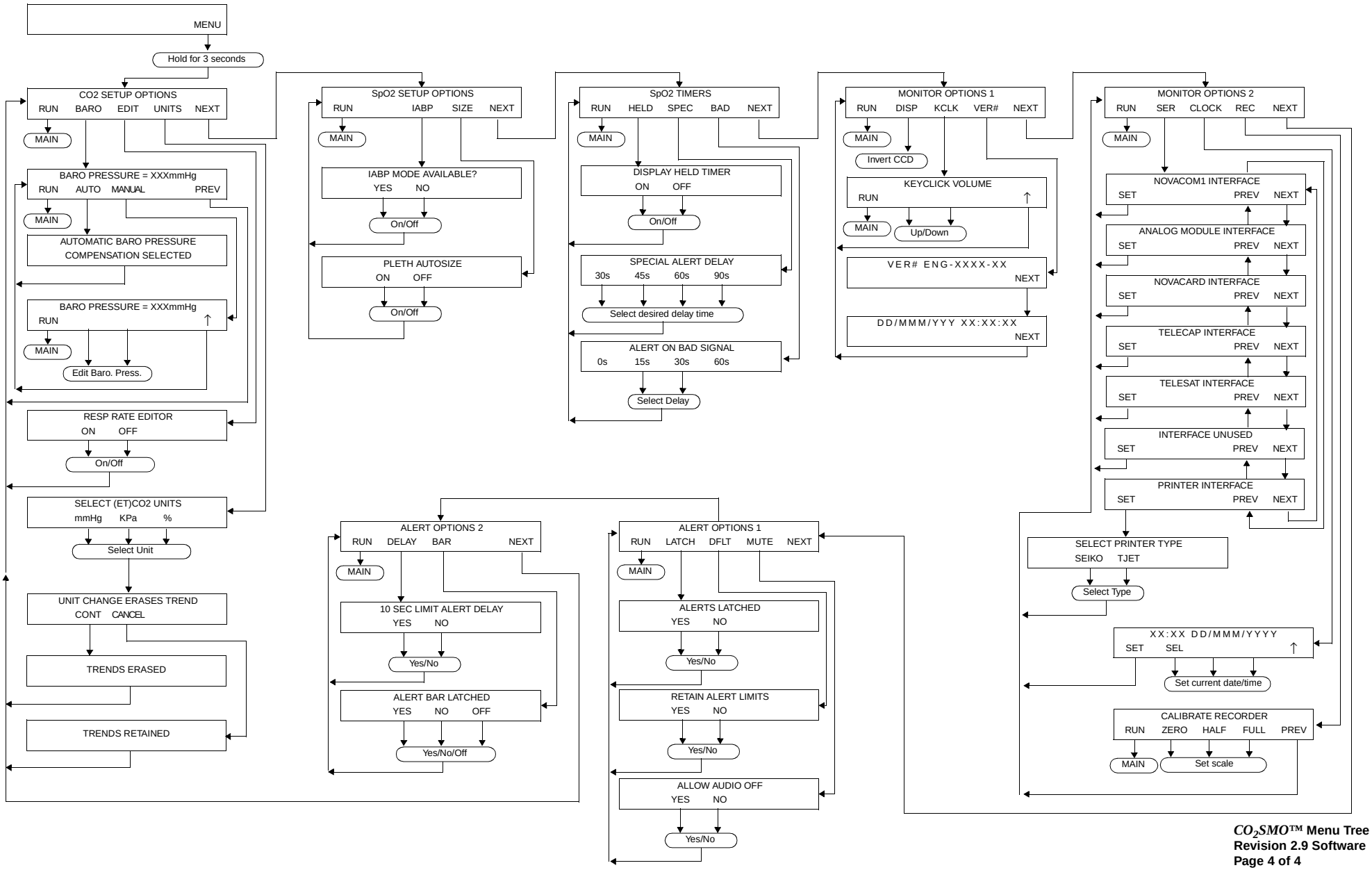

This menu is displayed for approximately 8 seconds on power-up, if niether key is pressed the Main Menu will appear.
ERASE STORED TRENDS ?
YES NO
TRENDS RETAINED
MAIN
TRENDS ERASED
MAIN
Pressing the EVENT key while in the Main Menu
EVENT MARKED XX:XX
Which Interface Selected
NOVACARD
Printer
None
WAVEFORM FROZEN
RUN
MAIN
WAVEFORM FROZEN
RUN PRINT
MAIN
PRINTOUT STARTED
MAIN
STORE WAVEFORM TO CARD ?
RUN STORE ID ERASE
MAIN
PATIENT ID:_ _ _ _ _ _ _ _ _
SET CLR SELECT
Edit Patient ID field
Clears Patient ID field
ABLE TO WRITE TO CARD?
No
Yes
CANNOT WRITE THIS CARD
ABLE TO WRITE TO CARD?
Yes
No
CANNOT ERASE THIS CARD
ERASE NOVACARD ?
YES NO
TRENDS RETAINED
ERASING NOVACARD
PLEASE WAIT
STORING WAVEFORM TO CARD
PLEASE WAIT
If mains and battery power is removed from the main board, when power is reapplied and the monitor is turned on this will appear for 3 seconds on power-up.
WARNING!
CHECK TIME/DATE
Placing Capnostat on Zero Cell
TIME REMAINING XX:XX
CANCEL
MAIN
PLACE ON REF CELL
CANCEL
MAIN
Placing Capnostat on Reference Cell after zero calibration.
CHECKING CALIBRATION
CALIBRATION VERIFIED
REMOVE SENSOR FROM CELL
MAIN
Place Capnostat on Reference Cell without Zero calibration first.
NOT CALIBRATED
PLACE ON ZERO CELL
Appears when monitor is powered up for factory default settings.
PARAMETERS RESET
TO FACTORY DEFAULTS
When the pump is turned on in the SET SAMPLING PUMP menu CAL CO2 CANNULA will appear on the display. Pressing the CAL key will produce the following menu sequence.
CO2 CANNULA ATTACHED ?
CONT CANCEL
MAIN
PLACE ON ADAPT IN RM AIR
START CANCEL
MAIN
Warmup Complete?
No
WAIT FOR SENSOR
CANCEL
MAIN
Yes
Wait for warmup
Breaths Detected ?
Yes
BREATHS DETECTED?
Wait 3 sec
TIME REMAINING : XX
CANCEL
MAIN
A Zero Successful ?
Yes
MAIN
No
CALIBRATION ERROR
CONT



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Section 12 *Status Messages*

Certain status messages may appear on the display of the CO_2SMO $ETCO_2/SpO_2$ monitor, Model 7100. These messages are listed in the following table with an explanation of the probable causes.

Message Displayed	Possible Explanation
ETCO2 SECTION	
CO2 SENSOR FAULTY 1	Try different sensor. If problem persists, a hardware error with the monitor most likely exists, or sensor is defective.
CO2 SENSOR FAULTY 2	The values stored inside the sensor's EEPROM failed the checksum test. Check that the sensor is properly plugged in. If problem persists, return the sensor to the factory for servicing.
CANNOT CALIBRATE THIS SENSOR	Occurrence of any of the following conditions - sensor is unplugged, over temperature, faulty, incompatible, or calibrator is faulty.
CO2 SENSOR WARM-UP	The CO_2 sensor has not reached proper operating temperature. A cold sensor may take several minutes to warm up; less time is necessary for a sensor at room temperature. Maximum warm-up time should be five minutes. Wait for sensor to stabilize. If error persists, try a different sensor. Other monitor functions are not affected.
WAIT FOR SENSOR	The sensor is unplugged, under temperature, over temperature or temperature is stabilizing. Other monitor functions are not affected.
CHECK AIRWAY ADAPTER **ADAPTER CAL?**	Usually caused by blockage of the optical path of the sensor, or when the airway adapter is removed. May also be caused by failure to perform adapter calibration to correct for adapter type. Clean airway adapter if necessary, check calibration. Perform adapter calibration, if problem persists, perform zero calibration. Perform another adapter calibration if using another adapter.
CONNECT CO2 SENSOR	CO_2 sensor not plugged into the monitor. This message will be displayed until a sensor is plugged into the CO_2 input connector.
CO2 SENSOR OVER-TEMP	Sensor temperature is greater than 50 degrees Celsius. Check that the sensor is not exposed to excess heat. If message persists, a hardware problem is likely.
INCOMPAT. CO2 SENSOR	The EEPROM inside the sensor contains a code that identifies the format of the information contained in the EEPROM. If the code is not recognized by the monitor's software, this message will occur. If this message occurs, return the sensor to the factory for servicing.

Message Displayed	Possible Explanation
PLACE ON ZERO CELL	A calibration error has been detected, or a new sensor has been connected. Place the sensor on the zero cell to recalibrate.
CO2 ADAPTER CAL ERR	Error detected during Adapter cal. This will occur if Airway Adapter is not connected or if CO_2 gas is present in the Airway Adapter during airway zero. Perform an adapter calibration to correct; if problem persists a possible hardware error exists.
ETCO2 OUT OF RANGE	The value being calculated is greater than 100mmHg. If error persists, check calibration and perform a zero calibration if necessary.
NOT CALIBRATED PLACE ON ZERO CELL	An uncalibrated sensor has been placed on the reference cell before having been zero calibrated on the zero cell.
CHECK SAMPLING LINE	The monitor has detected a leak in the sampling system.
SAMPLE LINE BLOCKED	Indicates line blockage in the sampling system.
CAL CO2 CANNULA	Displayed when sampling system pump is turned on. Calibration necessary for proper operation of sensor and pump current monitoring.
BARO. PRESSURE ERROR	Monitor detects invalid readings from the barometric pressure measuring circuit.
SATURATION SECTION	
SpO2 PROBE OFF PATIENT	Sensor disconnected from patient, improperly applied, or placed on an area too translucent for proper sensor operation. Reposition sensor.
SpO2 LOW SIGNAL	The signal strength detected by the sensor is weak, reposition sensor to a more perfused site.
SpO2 BAD SIGNAL	Monitor not receiving valid signals from sensor. May be caused by excessive motion, cardiac arrhythmia or other situations leading to poor signal. Check patient status, reposition sensor.
CAN'T I.D. SPO2 PROBE	Sensor is placed on patient before being connected to the monitor - always connect the sensor to the monitor first. A non-SuperBright™ sensor is connected. Sensor is faulty. Remove sensor from use and contact qualified service personnel.
CONNECT SpO2 PROBE	Sensor is disconnected from the monitor. Sensor is faulty. Remove sensor from use and contact qualified service personnel. Both sensor LEDs have failed or the cable connections are open or shorted.
SpO2 FAULTY PROBE	Sensor faulty. Remove sensor from use and contact qualified service personnel. This error traps intermittent faults such as Probe Red LED or Infrared LED failures caused by frayed or broken wires in the sensor cable.
SPO2 HARDWARE ERROR 1	Monitor's circuitry is outside of calibration limits. Contact factory for assistance.

Message Displayed	Possible Explanation
NO SPO2 UPDATE **	Insufficient light, where ** is time in seconds (after 99 seconds display shows "--"). Possibly caused by motion or poor sensor placement, resulting in poor signal.
INCOMP SPO2 PROBE	A non-SuperBright™ sensor is connected. Sensor is faulty. Remove sensor from use and contact qualified service personnel.
SpO2 INSUF. LIGHT	Sensor placed on a site too thick (or opaque) for adequate light transmission. Reposition the sensor. A non-SuperBright™ sensor is connected.
SpO2 LIGHT INTERF	Light Interference, ambient light sources (sunlight, warming lights, etc.) are interfering with sensor light sources. Shield the sensor from ambient light sources.
SpO2 LOW SIGNAL	Low Signal Strength, the pulse strength detected by the sensor is too weak for proper monitor operation. Reposition sensor.
SpO2 FAULTY PROBE RD	Sensor faulty. Remove sensor from use and contact qualified service personnel. Sensor Red LED has failed or the cable connections are open or shorted.
SpO2 FAULTY PROBE IR	Sensor faulty. Remove sensor from use and contact qualified service personnel. Sensor Red IR has failed or the cable connections are open or shorted.
PULSE OUT OF RANGE	Pulse rate is less than 30 bpm or is greater than 250 bpm.
MONITOR	
AUDIO OFF DISABLED	Displayed if user tries to enable Audio Off mode (by pressing and holding the **AUDIO** key) while the "Allow Audio Off" portion of the Options Menu is set to "No".
NOVAMETRIX MEDICAL SYSTEMS INC. COSMO SELF TEST IN PROGRESS.	Monitor is performing power-up system diagnostic tests that check the system RAM and ROM. If a failure in testing RAM is encountered, the monitor will flash three front panel LEDs. If a failure in ROM is encountered, the two outer LEDs will flash; the monitor will not function in either case.
PARAMETERS RESET TO FACTORY DEFAULTS	Displayed when monitor is turned on while pressing the **ALERT RESET** key. Monitor is now using factory default settings. This message will also appear if new software has been installed. The monitor will perform a self test and check the RAM and ROM then reset to the factory default settings.
BATTERY VERY LOW PLUG IN AC POWER	Monitor is running on battery power and the battery power has been depleted. Connect line cord to AC Mains power source and set the rear panel switch to "|". Monitor's rear panel fuse has blown, monitor switched over to battery power and has depleted battery life.
WARNING! CHECK TIME/DATE	Displayed for approximately two seconds on power up if both AC mains and battery power are removed from the main board. Set proper Time/Date to eliminate message from appearing on power up.

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Section 13 Using a Printer

CO_2SMO directly supports specific RS232 serial printers[1]. They include the Seiko DPU-414 and DPU 411 Thermal Printers, and the Hewlett-Packard ThinkJet Printer.[2]

The information output by the printers is the same. However, due to printer differences, the format of the printed information will vary slightly between printers.

Selecting a Specific Printer

The CO_2SMO must be set to the appropriate printer interface.

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Repeatedly press the **NEXT** key until MONITOR OPTIONS 2 appears.
3. Press the **SER** (serial interface) key and the currently selected interface appears.
   Available interfaces include INTERFACE UNUSED, PRINTER INTERFACE, NOVACOM 1 INTERFACE, ANALOG MODULE INTERFACE, NOVACARD INTERFACE, TELECAP INTERFACE, and TELESAT INTERFACE.
4. Press **PREV** (previous) or **NEXT** to select PRINTER INTERFACE.
5. Press the **SET** key. SELECT PRINTER TYPE appears.
   The currently selected printer type flashes.
6. Press the **SEIKO** or **TJET** key as desired.
7. Press **RUN** to return to the Main Menu.
   When Printer Interface Mode is selected, a **PRNT** (print) softkey is added to the SYSTEM OPTIONS and TREND OPTIONS menus.

Connecting the Seiko DPU-414 Thermal Printer

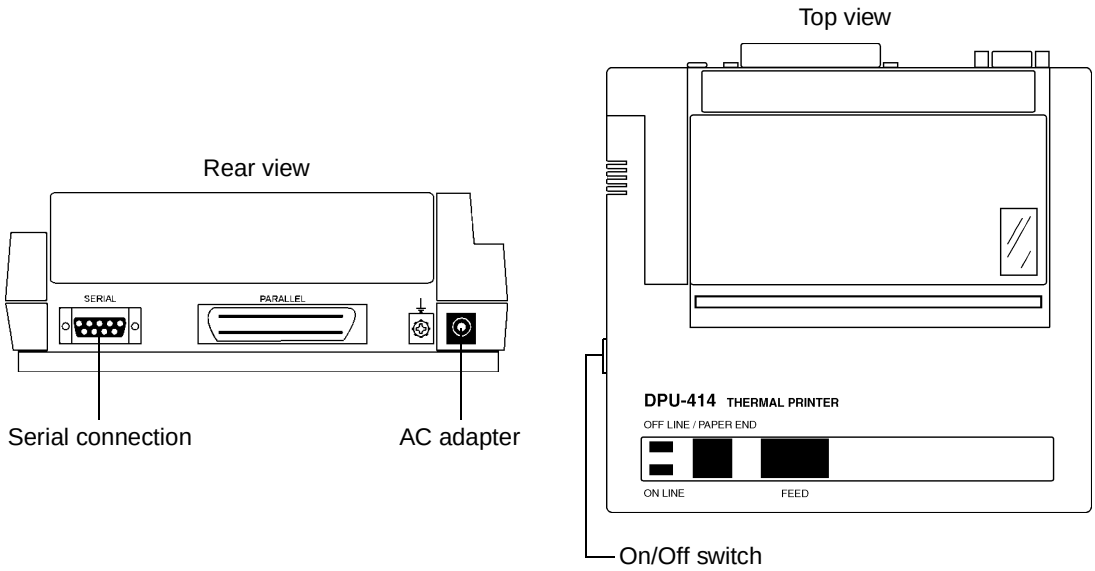
To connect a Seiko DPU-414 Thermal Printer (PN: 9140-00) to the CO_2SMO:

1. Connect the 9085-00 interface cable to the monitor‘s RS232 connector and to the printer’s serial input connector—the 9 pin D connector.
2. Connect the AC adapter and turn the printer on.

1 See “Analog Output Module” on page 71, for details on analog type printers and recorders.
2 Only the Seiko DPU-414 Thermal Printer is currently available. Information on the Seiko DPU-411, and HP Thinkjet printers remains for backward compatibility.

Configuring the Seiko DPU-414 Printer

The Seiko DPU-414 Thermal Printer (Cat. No. 9140-00) must be configured to communicate with the CO_2SMO. When properly configured, the Seiko printer will retain the settings, even when turned off.



Setting the DIP switches:

1. Slide the printer's power switch to OFF "O".
2. Press and hold the **ON LINE** button, then slide the power switch ON "|". Release the **ON LINE** button after the list of current settings starts printing out.
3. The printout of the current settings is followed by the prompt:

   "Continue? : Push On-line SW"
   "Write? : Push Paper feed SW"

   To change the DIP switch settings, push the **ON LINE** button (to leave the DIP switch settings unchanged, push the **FEED** button).
4. "DIP SW-1" will print. Enter the new settings for switches 1-8.

   "ON" is set by pushing the **ON LINE** button once
   "OFF" is set by pushing the **FEED** button once

   The printer will confirm each selection. Repeat for DIP SW 2 and 3.

The DIP switch settings for the Model 7100 are as follows:

```
[ DIP SW settings mode ]

Dip SW-1

    1 (OFF) : Input = Serial
    2 (ON ) : Printing Speed = High
    3 (ON ) : Auto Loading = ON
    4 (OFF) : Auto LF = OFF
    5 (ON ) : Setting Command = Enable
    6 (OFF) : Printing
    7 (ON ) :   Density
    8 (ON ) :   = 100 %

Dip SW-2

    1 (ON ) : Printing Columns = 40
    2 (ON ) : User Font Back-up = ON
    3 (ON ) : Character Select = Normal
    4 (OFF) : Zero = Normal
    5 (ON ) : International
    6 (OFF) :   Character
    7 (ON ) :   Set
    8 (OFF) :   = U.S.A.

Dip SW-3

    1 (ON ) : Data Length = 8 bits
    2 (ON ) : Data Parity = No
    3 (ON ) : Parity Condition = Odd
    4 (OFF) : Busy Control = H/W Busy
    5 (ON ) : Baud
    6 (OFF) :   Rate
    7 (ON ) :   Select
    8 (OFF) :   = 9600 bps

Continue ? : Push 'On-line SW'
Write ?    : Push 'Paper feed SW'
```

CAUTION

DIP SW Set Mode cannot be cancelled once it is initiated. Answer "ON" or "OFF" for every setting.

Note: More information about DIP switch settings can be found in the Seiko "DPU-414 Thermal Printer Operation Manual."

5. When the printer finishes writing the new settings to memory, "DIP SW setting completed!!" is printed out and the printer returns to ON LINE mode.

CAUTION

Never turn the printer off while it is writing the new settings to memory. Wait until "DIP SW setting complete!!" is printed, then the printer power may be turned off.

Connecting the Seiko DPU-411 Printer

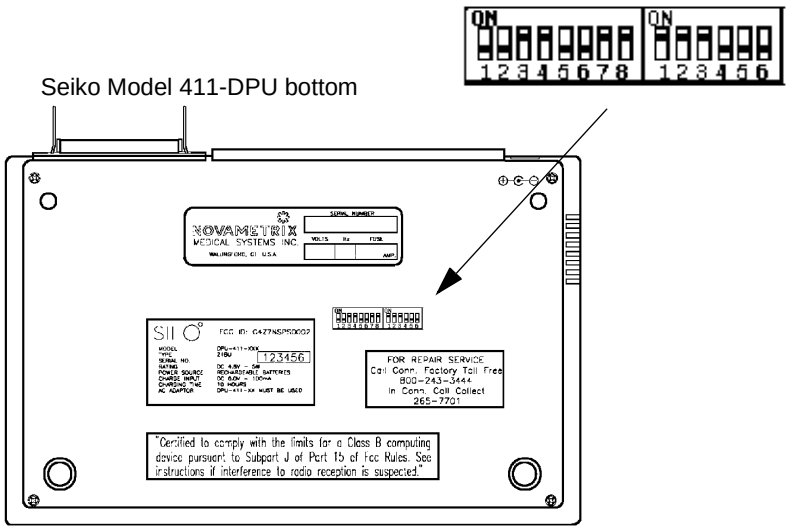
The Seiko DPU-411 thermal printer (Cat. No. 5702-00 for 120 vac, 5703-00 for 220 vac) can be used with the CO_2SMO for trend or tabular printouts. The Seiko DPU-411 printer and the CO_2SMO must be correctly configured before they can operate properly. An interface cable connects the two devices.

Interface cable Catalog No. 5861-00 is twelve inches long and allows the Seiko DPU-411 printer to be powered from the CO_2SMO. The printer's AC adapter is not needed.

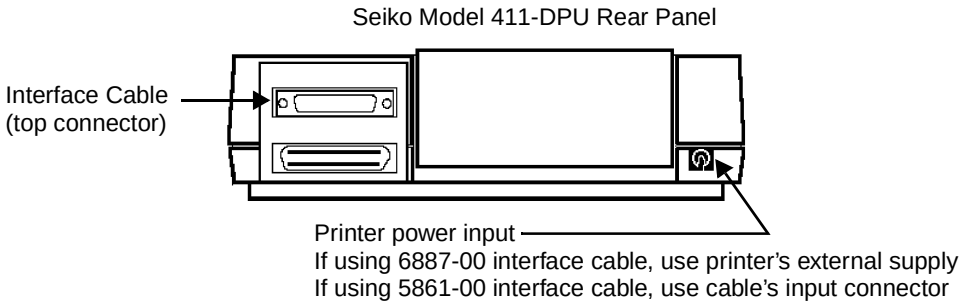
Interface cable Catalog No. 6887-00 is a six foot cable that requires the Seiko DPU-411 printer to be powered from its AC adapter.

To configure and connect the Seiko DPU-411 thermal printer:

1. Ensure that the printer is off.
2. Set the DIP switches on the bottom of the DPU-411 to the proper settings.
   First set of eight switches: 1-2 OFF, 3-4 ON, 5-6 OFF, 7-8 ON
   Second set of six switches: 1-3 ON, 4-6 OFF.


Seiko Model 411-DPU bottom
ON
1 2 3 4 5 6 7 8
ON
1 2 3 4 5 6
NOVAMETRIX
MEDICAL SYSTEMS INC.
123456
FOR REPAIR SERVICE
Call Conn. Factory Toll Free
800-243-3444
In Conn. Call Collect
265-7701
"Certified to comply with the limits for a Class B computing device pursuant to Subpart J of Part 15 of Fcc Rules. See instructions if interference to radio reception is suspected."

3. Connect a printer interface cable between the CO_2SMO's RS232 connector and the printer's upper rear panel connector. If using the 6887-00 cable, connect the printer's external power supply to its rear panel and the AC supply. If using the 5861-00 cable, connect the cable's power supply connector to the printer power input connector.

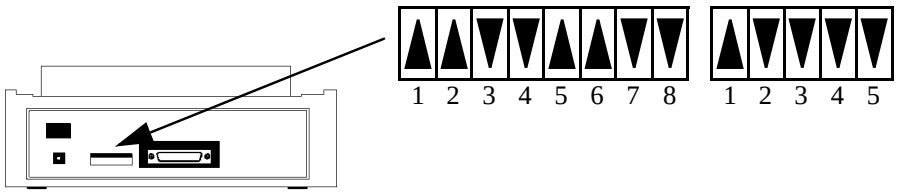

Seiko Model 411-DPU Rear Panel
Interface Cable
(top connector)
Printer power input
If using 6887-00 interface cable, use printer's external supply
If using 5861-00 interface cable, use cable's input connector

4. Turn the printer ON. Refer to the Seiko Model DPU-411 documentation for specific printer operation and maintenance instructions.

Connecting the Hewlett-Packard ThinkJet Printer

To connect the Hewlett-Packard ThinkJet Printer to CO_2SMO:

1. The ThinkJet must be a Hewlett-Packard Model 2225D (RS232 serial interface).
2. Set the dip switches on the rear panel of the ThinkJet as indicated below.



Mode switches = 1, 2, 5, 6 up (on) and 3, 4, 7, 8 down (off).
RS-232C switches = 1 up (on) and 2, 3, 4, 5 down (off).

3. Connect the interface cable (Catalog No. 5331-00) to the monitor‘s RS232 connector and to the printer’s serial input connector. Markings at each end of the cable help orient it properly.
4. Connect the printer’s power cord and turn the printer on.
5. Refer to the ThinkJet Owner’s Manual for further printer details.

Print Formats

The information output by the printers is the same. However, due to printer differences, the format of the printed information will vary slightly between printers.

The following print types are available:

- Displayed Trend Printout
- Tabular Mode Text Printout
- Capnogram or Plethysmogram Waveform Printout
- Zoom Trend Printout
- Compressed Trend Printout

Displayed Trend Printout

To create a Displayed Trend Printout from the graphical or histogram trend display:

1. Ensure the selected printer is connected and ready to print.
2. Press the **TRND** key to display trend data.
3. Press **EXPAND** to select the 12 hour, 8 hour, 2 hour, or 30 minute trend display.

   The start and stop times for the printed graph and histogram are approximately (due to compression) the same as those displayed on the monitor trend display when the printout is initiated.
4. Press the **NEXT** key. TREND OPTIONS appears.

5. Press **PRNT**. PRINTOUT STARTED is displayed and printing starts.

   The user can also press **PRNT** in the histogram display—the printout will be the same.

   The printer stops automatically when the printout is complete.

   If **PRNT** is pressed again before the printout finishes, PRINT IN PROGRESS appears. Press **STOP** to terminate printing, or press **CONT** (continue) to resume printing.

6. TREND OPTIONS reappears. Press **RUN** to return to the Main Menu.

Tabular Mode Text Printout

Tabular Mode Printouts print the time, SpO_2, Pulse Rate, $ETCO_2$, Respiratory Rate and Inspired CO_2 values once each 30 seconds. The printed values reflect the monitor's display at the instant of printing.

To start a Tabular Mode Printout:

1. Ensure the selected printer is connected and ready to print.
2. Press the **MENU** key then the **NEXT** key. SYSTEM OPTIONS appears.
3. Press the **PRNT** key. SELECT PRINT MODE appears.
4. Press the **TAB** (tabular) key. PRINTOUT STARTED is displayed and printing starts.

To stop a Tabular Mode Printout:

1. Press the **MENU** key then the **NEXT** key. SYSTEM OPTIONS appears.
2. Press the **PRNT** key. PRINT IN PROGRESS appears.
3. Press **STOP** to stop the printout, or press **CONT** to continue with the Tabular Mode Text Printout.

Capnogram or Plethysmogram Waveform Printout

To start a capnogram or plethysmogram waveform printout:

1. Ensure the selected printer is connected and ready to print.
2. Press the **EVENT** key; EVENT MARKED hh:mm will appear, followed by PRINT WAVEFORM?

   The hh:mm will be the time stamped by the monitor.

3. Press the **PRNT** key or **RUN** key as desired.

   Press **PRNT** to print the waveform. If the capnogram or dual waveform display is selected, a capnogram is printed; if the plethysmogram display is selected, a plethysmogram is printed. The printer stops automatically when the printout is complete.
   Press **RUN** to return to the Main Menu without printing.

Zoom Trend Printout

To create a Zoom Trend Printout:

1. Ensure the selected printer is connected and ready to print.
2. Press the **MENU** key then the **NEXT** key. SYSTEM OPTIONS appears.
3. Press the **PRNT** key. SELECT PRINT MODE appears.
4. Press the **TRND** key. PRINT TREND appears.

5. Press **PART**. The START time menu appears.
6. Press ↑ or ↓ to select the point (time) in trend memory to start the printout.
7. Press the **SET** key. The STOP time menu appears.

   Or, press **RESET** to reset the start time to the beginning of trend memory.
8. Press ↑ or ↓ to select the point (time) in trend memory to stop the printout.
9. Press **PRINT**.

   Or, press **RESET** to set the stop time to the programmed start time.
10. PRINTOUT STARTED is displayed and printing starts.

    If the capnogram display is selected, $ETCO_2$ and Respiratory Rate data is printed; if the plethysmogram display is selected, SpO_2 and Pulse Rate data is printed. The printer stops automatically when the printout is complete.

    If **PRNT** is pressed again before the printout finishes, PRINT IN PROGRESS appears. Press **STOP** to terminate printing, or press **CONT** (continue) to resume printing.

Compressed Trend Printout

To create a Compressed Trend Printout:

1. Ensure the selected printer is connected and ready to print.
2. Press the **MENU** key then the **NEXT** key. SYSTEM OPTIONS appears.
3. Press the **PRNT** key. SELECT PRINT MODE appears.
4. Press **TREND**. PRINT TREND appears.
5. Press **ALL**. SELECT TREND COMPRESSION appears.
6. Select **NONE**, **1/2**, **1/4** or **PAGE**.

   NONE. Printout length of up to 12 sheets of paper (standard 8.5 x 11 inch sheets)
   1/2. Printout length of up to 6 sheets of paper
   1/4. Printout length of up to 3 sheets of paper
   PAGE. Printout sized to fit a single sheet of paper.
7. PRINTOUT STARTED is displayed and printing starts.

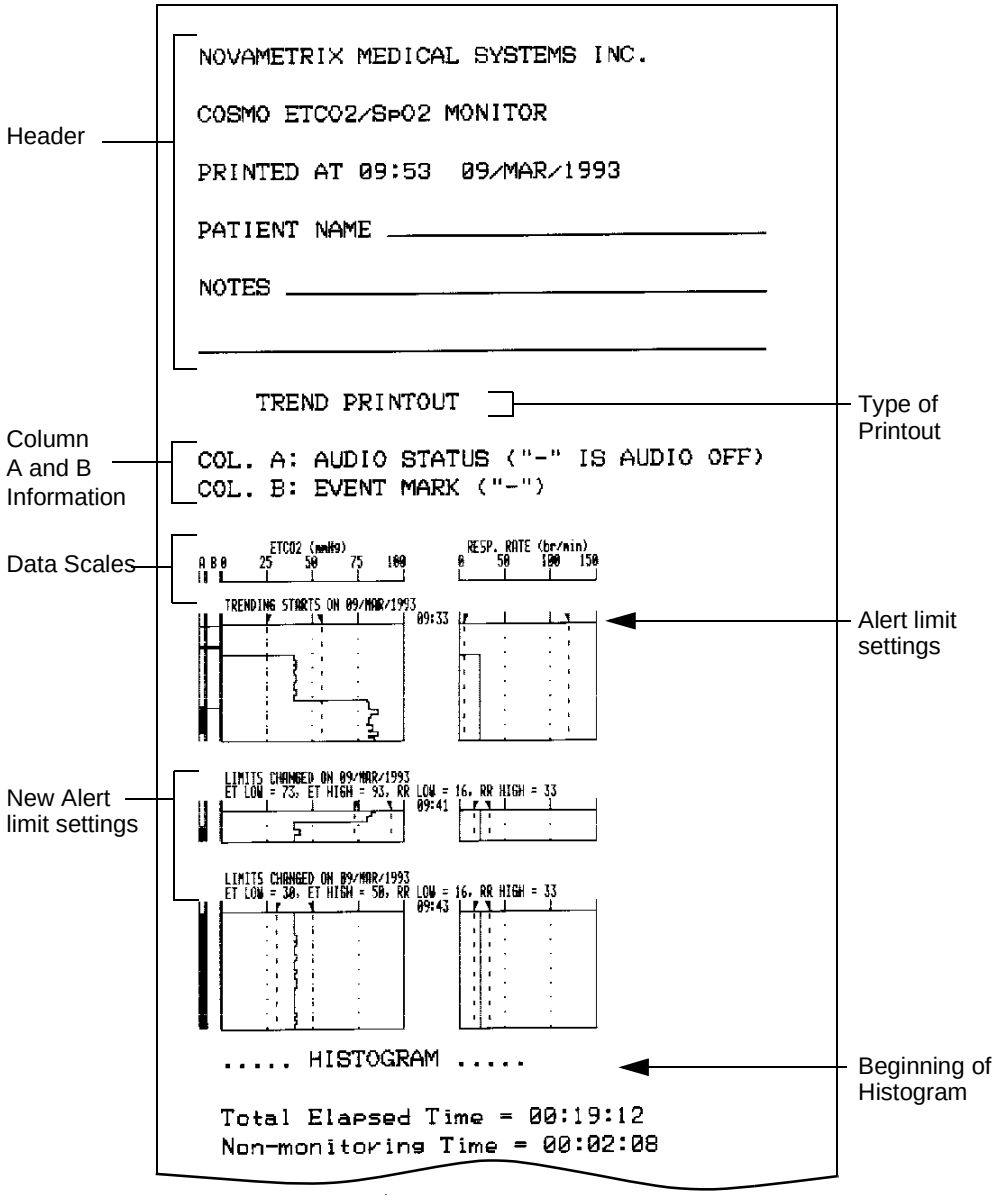
   If the capnogram or dual waveform display is selected, $ETCO_2$ and Respiratory Rate data is printed; if the plethysmogram display is selected, SpO_2 and Pulse Rate data is printed. The printer stops automatically when the printout is complete.

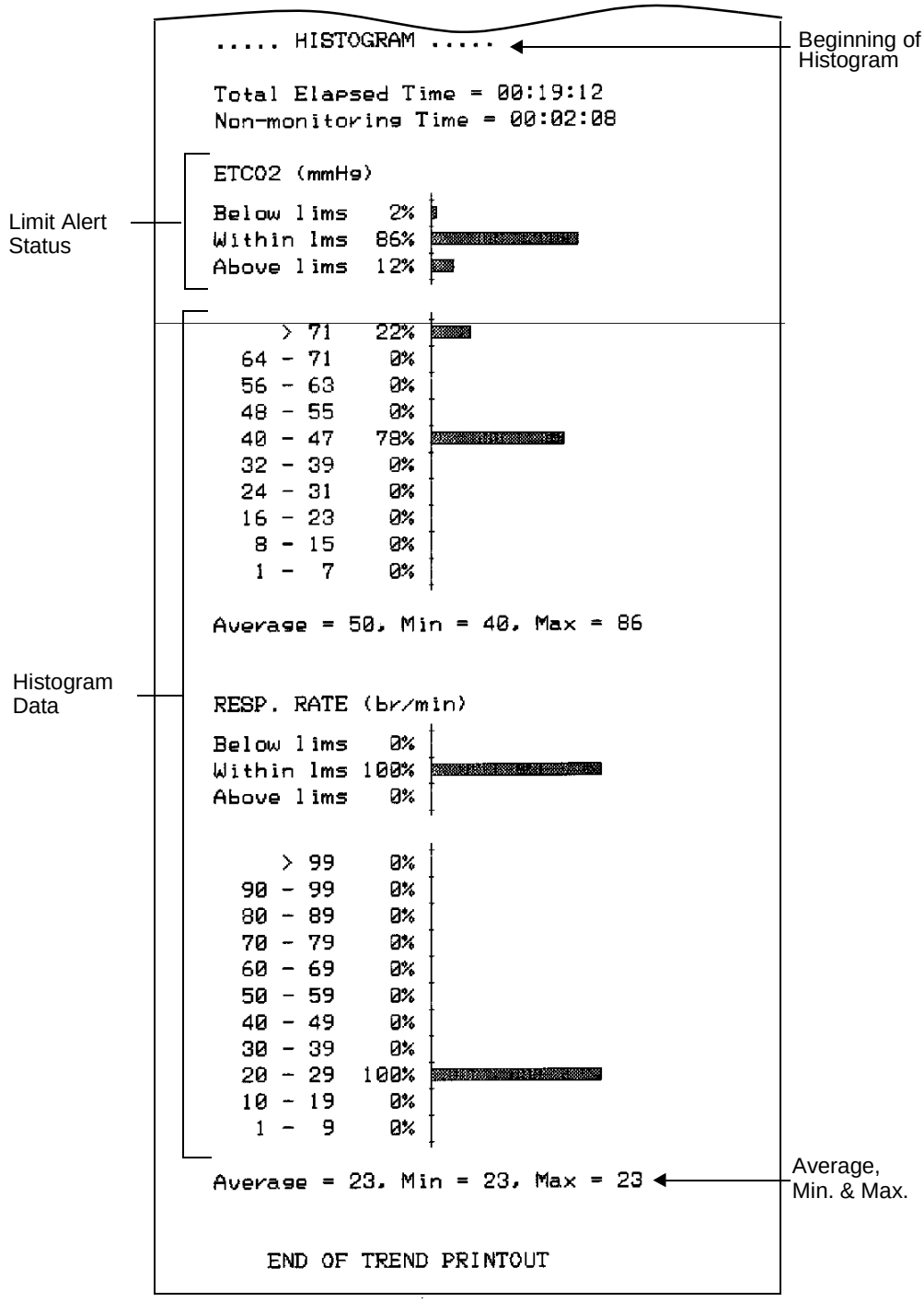
   If **PRNT** is pressed again before the printout finishes, PRINT IN PROGRESS appears. Press **STOP** to terminate printing, or press **CONT** (continue) to resume printing.

Interpreting Printer Output

Header

Each printout starts with a header that identifies the monitor (CO_2SMO $ETCO_2/SpO_2$ Monitor). The date and time of the printout is furnished by the monitor's calendar/clock. Space is then provided to enter patient information. The type of printout (Zoom, Compressed, etc.) is then identified.


Header
NOVAMETRIX MEDICAL SYSTEMS INC.
COSMO ETCO2/SpO2 MONITOR
PRINTED AT 09:53 09/MAR/1993
PATIENT NAME
NOTES
TREND PRINTOUT
Type of Printout
Column A and B Information
COL. A: AUDIO STATUS ("-" IS AUDIO OFF)
COL. B: EVENT MARK ("-")
Data Scales
ETCO2 (mmHg)
RESP. RATE (br/min)
TRENDING STARTS ON 09/MAR/1993
09:33
Alert limit settings
LIMITS CHANGED ON 09/MAR/1993
ET LOW = 73, ET HIGH = 93, RR LOW = 16, RR HIGH = 33
09:41
New Alert limit settings
LIMITS CHANGED ON 09/MAR/1993
ET LOW = 30, ET HIGH = 50, RR LOW = 16, RR HIGH = 33
09:43
..... HISTOGRAM .....
Beginning of Histogram
Total Elapsed Time = 00:19:12
Non-monitoring Time = 00:02:08


..... HISTOGRAM .....
Beginning of Histogram
Total Elapsed Time = 00:19:12
Non-monitoring Time = 00:02:08
ETCO2 (mmHg)
Limit Alert Status
Below lims 2%
Within lms 86%
Above lims 12%
> 71 22%
64 - 71 0%
56 - 63 0%
48 - 55 0%
40 - 47 78%
32 - 39 0%
24 - 31 0%
16 - 23 0%
8 - 15 0%
1 - 7 0%
Average = 50, Min = 40, Max = 86
Histogram Data
RESP. RATE (br/min)
Below lims 0%
Within lms 100%
Above lims 0%
> 99 0%
90 - 99 0%
80 - 89 0%
70 - 79 0%
60 - 69 0%
50 - 59 0%
40 - 49 0%
30 - 39 0%
20 - 29 100%
10 - 19 0%
1 - 9 0%
Average = 23, Min = 23, Max = 23
Average, Min. & Max.
END OF TREND PRINTOUT

Graphical Data

A graphical depiction of trend memory is printed after the header for all printouts except the tabular and waveform modes.

Column A and B Information: The next two lines refer to Columns A and B in the printout. Column A represents the monitor's audible alarm status. A mark (black bar) in this column indicates that the audible alarms were silenced during this portion of the printout. Column B shows marks where "Events" were added to trend memory.

Data Scales: The $ETCO_2$ and Respiratory Rate scales, or Pulse Rate and SpO_2 scales, are printed and dotted lines within the data section correspond to the major divisions shown on the scale lines.

Alert Limit Settings: Following the data ratio and just before the actual data are the alert limit settings. Each scale has two triangle shaped markers that represent the upper and lower alert limit settings as shown on the monitor's display. Dashed lines extend from these markers down into the data section of the printout. If the alert limits were changed during the time the printed data was originally collected, the new alert limits will be printed with a message indicating that the limits were changed.

Data Section: The data is printed based on the compression ratio. A time stamp is placed at regular intervals and appears as a horizontal line printed between the scales.

Histogram Data

A histogram based on the printed portion of trend memory is printed after the graphical data for all trend printouts.

Total Elapsed Time: Time trending was active; the total time covered by the printout.

Non-Monitoring Time: For CO_2 trends, this is usually time spent with the CAPNOSTAT on the calibration cells. For SpO_2 trends, this is time spent in SpO2 PROBE OFF PT or a similar non-monitoring condition.

Limit Alert Status: Percent of monitoring time spent above, below and within the parameter alert limits as shown on the printout.

Histogram Data: A numerical and graphical display of the percentage of monitoring time (non-monitoring time excluded) spent in each of the ranges listed.

Average, Min and Max: The minimum and maximum recorded values. Average refers to the arithematic mean of all readings.

End of Trend Printout: Message shows Histogram is a part of the Print Trend feature.

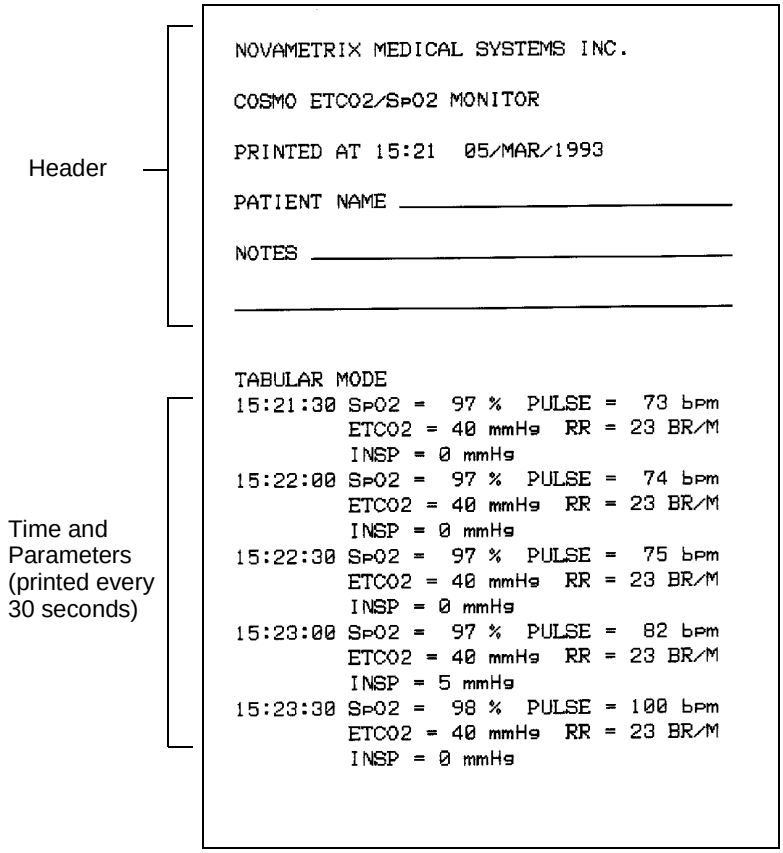
Tabular Data Format

Tabular Mode Text Printouts start off with a Header (refer to previous section), followed text printed at 30 seconds intervals.

The format of the tabular text is:

HH:MM:SS SpO2 = XXX % PULSE = XXX bpm ETCO2 = XXX mmHg RR
= XXX BR/M INSP = XXX mmHg

where HH:MM:SS is the hour, minute and seconds (24 hour format) and XXX is the appropriate displayed parameter value.


Header
Time and Parameters (printed every 30 seconds)
NOVAMETRIX MEDICAL SYSTEMS INC.
COSMO ETCO2/SpO2 MONITOR
PRINTED AT 15:21 05/MAR/1993
PATIENT NAME
NOTES
TABULAR MODE
15:21:30 SpO2 = 97 % PULSE = 73 bpm
ETCO2 = 40 mmHg RR = 23 BR/M
INSP = 0 mmHg
15:22:00 SpO2 = 97 % PULSE = 74 bpm
ETCO2 = 40 mmHg RR = 23 BR/M
INSP = 0 mmHg
15:22:30 SpO2 = 97 % PULSE = 75 bpm
ETCO2 = 40 mmHg RR = 23 BR/M
INSP = 0 mmHg
15:23:00 SpO2 = 97 % PULSE = 82 bpm
ETCO2 = 40 mmHg RR = 23 BR/M
INSP = 5 mmHg
15:23:30 SpO2 = 98 % PULSE = 100 bpm
ETCO2 = 40 mmHg RR = 23 BR/M
INSP = 0 mmHg

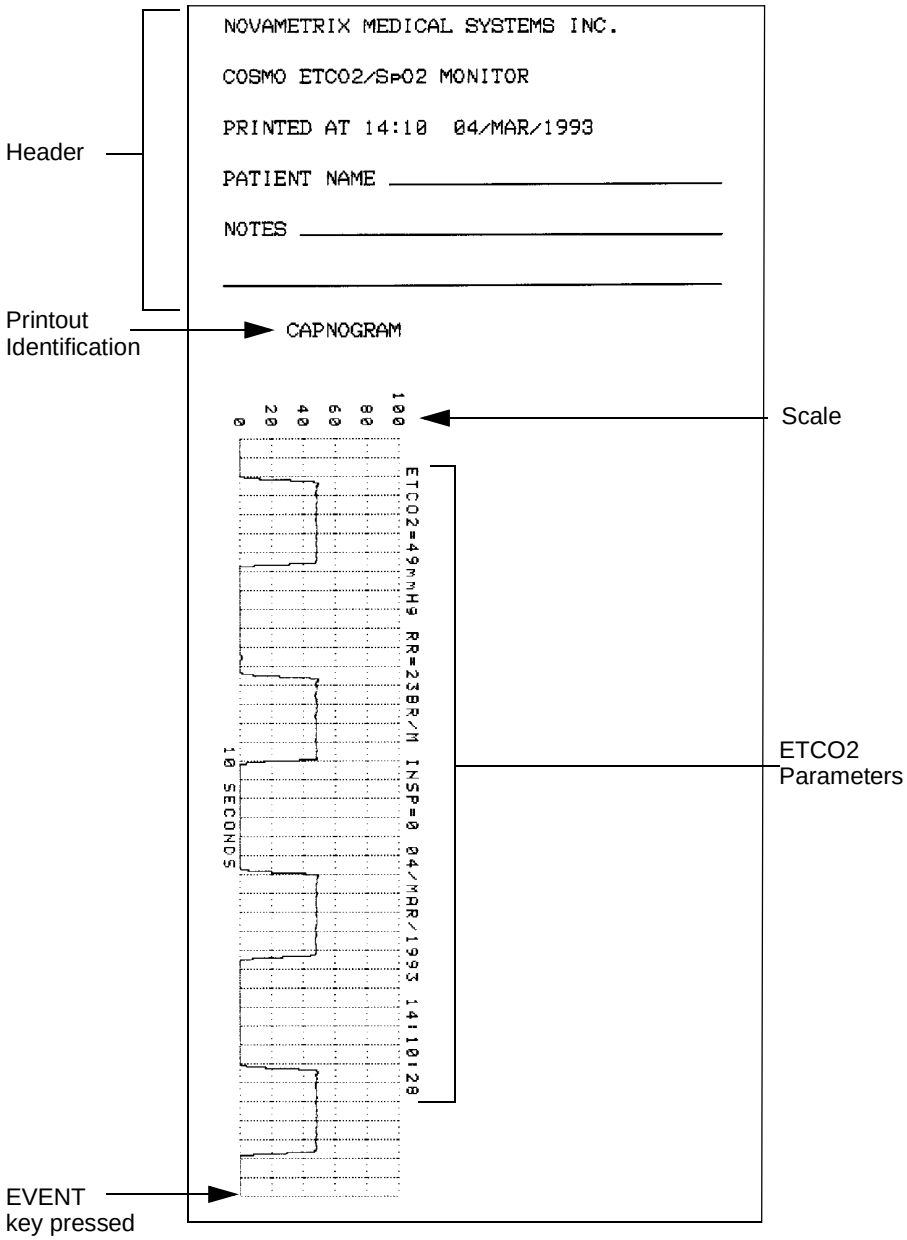
Capnogram or Plethysmogram Waveform Format

If the capnogram or dual waveform display is selected, a capnogram waveform is printed; if the plethysmogram display is selected, a plethysmogram waveform is printed. The printer stops automatically when the printout is complete.

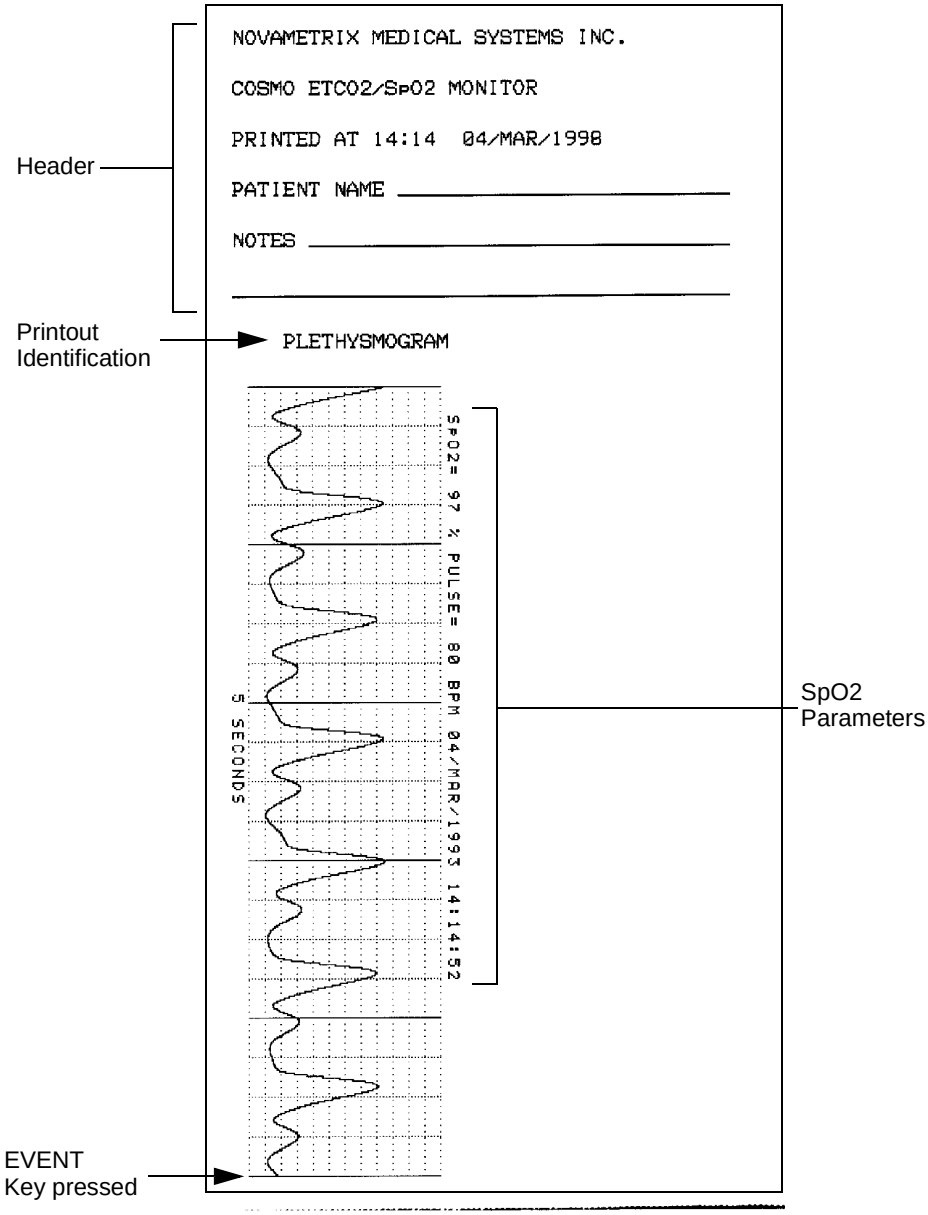
Waveform Printouts start off with a Header (refer to previous section).

A Capnogram Waveform Printout represents the ten seconds of capnogram data immediately prior to when the **EVENT** key was pressed. Graphically, the **EVENT** key press corresponds to the bottom of the printout; the top of the printout is ten seconds before **EVENT** was pressed. The time, and $ETCO_2$,

Respiratory Rate and Inspired CO_2 values are also printed. The printed values reflect the monitor's display at the instant of printing.



A Plethysmogram Waveform Printout represents the five seconds of plethysmogram data immediately prior to when the **EVENT** key was pressed. Graphically, the **EVENT** key press corresponds to the bottom of the printout; the top of the printout is five seconds before **EVENT** was pressed. The time, SpO_2 and Pulse Rate values are also printed. The printed values reflect the monitor's display at the instant of printing.



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Section 14 External Devices

CO_2SMO supports, in addition to the printers previously mentioned, specific external RS232 serial devices: computer interface (*NOVACOM1*), Analog Module, Memory Card (*NOVACARD*), Telecap, and TeleSat. For information on printers see "Using a Printer" on page 85.

NOVACOM1 Interface

The *NOVACOM1* interface is designed to output data in formats easily read by a computer or data logging device. The computer interface provides the user several communication modes to choose from. The communication format is 9600 baud, 8 bits, no parity, 1 stop bit and XON/XOFF handshaking.

Mode 1 — Real Time

In Real Time mode, the end tidal CO_2, respiratory rate and inspired CO_2 values for the $ETCO_2$ section, and the saturation values, and respiration rate for the SpO_2 section are continually transmitted at one second intervals.

To enter Real Time mode, the computer must send an ASCII "1" character. The CO_2SMO will echo back the "1" followed by a <cr><lf>, and enable real time communication. The data format is,

```
ME***R***I**Y**S***P***Z**<cr><lf>
```

where;
M - Event Marker identifier, "M"= event marked, "-"= no event,
E - an identifier for the a 3-digit ASCII CO_2 value to follow,
R - an identifier for the 3-digit ASCII Resp. rate value to follow,
I - an identifier for the 2-digit ASCII Inspired CO_2 value to follow,
Y - an identifier for a 2-digit ASCII CO_2 status (message) value
S - an identifier for a 3-digit ASCII SpO_2 value to follow,
P - an identifier for a 3-digit ASCII Pulse value to follow,
Z - an identifier for a 2-digit ASCII SpO_2 status (message) value
*** - a 3-digit ASCII value,
** - a 2-digit ASCII value,
<cr><lf> - a carriage return, line-feed sequence.

CAUTION

If the units parameter is set to Kpa or % in the CO2 SETUP OPTIONS menu then the E*** and I** will include decimal characters and be in an E**.* format for End Tidal value, and I*.* for Inspired. This is an additional ASCII character in the sequence.

CAUTION

If the $ETCO_2$ section is turned off while the SpO_2 section remains on the E, R, and I fields will be followed by blanks. Likewise the S and P fields will be followed by blanks if the SpO_2 section is turned off while the $ETCO_2$ section remains on.

The Y** (CO_2) and Z** (SpO_2) values correspond to CO_2SMO display messages (e.g., "Check Airway Adapter"). The messages corresponding to the displayed numbers are shown below.

Y where ** is:**	**Capnometer messages**	**Z** where ** is:**	**SpO_2 messages**
00	No Error	00	No Error
01	N/A	01	N/A
02	Connect CO_2 Sensor	02	SpO_2 Low Signal
03	CO_2 Sensor Overtemp	03	SpO_2 Insuf Light
04	CO_2 Sensor Faulty	04	Pulse Out of Range
05	Incomp CO_2 Sensor	05	N/A
06	Calibrator Faulty	06	SpO_2 Light Interf
07	CO_2 Sensor Warm-up	07	SpO_2 Reflex Probe Off
08	(same as above)	08	SpO_2 Probe Off Patient
09	Place on Zero Cell	09	Connect SpO_2 Probe
10	(same as above)	10	Incomp SpO_2 Probe
11	CO_2 Zero Cal Error	11	Can't ID SpO_2 Probe
12	N/A	12	SpO_2 Faulty Probe Ir
13	CO_2 Adapter Cal Error	13	SpO_2 Faulty Probe Rd
14	Cal on Airway Adapt	14	SpO_2 Faulty Probe
15	Check Airway Adapt	15	N/A
16	(same as above)	16	SpO_2 Hardware Err
17	$ETCO_2$ Out of Range	17	SpO_2 Bad Signal
18	N/A		
19	Baro Press Error		
20	Check Sampling Line		
21	Sample Line Blocked		

To exit Real Time mode, the computer must send an "x" or "X" character. The CO_2SMO will echo the "x" and then stop real time communication.

Mode 3 — CO_2 Waveform

In CO_2 Waveform mode, the end tidal value, respiratory rate, inspired CO_2 and CO_2 error messages, are continually transmitted at one second intervals. CO_2 waveform data is also continually transmitted 48 times per second.

To enter CO_2 Waveform mode, the computer must send an ASCII "3" character. The CO_2SMO will echo the "3" followed by a <cr><lf> and then enable communication. The data format is:

ME***R***I**Y**<cr><lf> (sent once a second)
c++<cr><lf> (sent 48 times a second)

where:
M - Event Marker identifier, "M"= event marked, "-"= no event,
E - an identifier for a 3-digit ASCII CO_2 value to follow,
R - an identifier for a 3-digit ASCII Resp. rate value to follow,
I - an identifier for the 2-digit ASCII Insp. CO_2 value to follow,
Y - an identifier for a 2-digit ASCII CO_2 status (error) value
*** - a 3-digit ASCII value,
** - a 2-digit ASCII value,
c - an identifier for a 2-digit waveform data point to follow,
++ - a 2-digit ASCII value (in the range 0-99),
<cr><lf> is a carriage return, line-feed sequence.

The Y** (CO_2-Error message) value represents the current status of the parameter. A value of "00"is returned if no error is active. Refer to "Mode 1 — Real Time" on page 99 for a complete list of error messages.

To exit CO_2 Waveform mode, the computer must send an ASCII "x" or "X" character. The CO_2SMO will echo "x" and stop communication.

Mode 4 — SpO_2 Waveform

In SpO_2 Waveform mode, the saturation, pulse rate, and SpO_2 display messages, are continually transmitted at one second intervals. Plethysmogram waveform data is also continually transmitted 48 times a second.

To enter SpO_2 Waveform mode, the computer must send an ASCII "4" character. The CO_2SMO will echo the "4" followed by a <cr><lf> and then enable communication.
The data format is,

MS***P***Z**<cr><lf> (sent once a second)
p++<cr><lf> (sent 48 times a second)

where;
M - Event Marker identifier, "M"= event marked, "-"= no event,
S - an identifier for a 3-digit ASCII SpO_2 value to follow,
P - an identifier for a 3-digit ASCII Pulse rate value to follow,
Z - an identifier for a 2-digit ASCII SpO_2 status value
*** - a 3-digit ASCII value,
** - a 2-digit ASCII value,
p - an identifier for a 2-digit waveform data point to follow,
++ - a 2-digit ASCII value (in the range 0-99),
<cr><lf> is a carriage return, line-feed sequence.

The Z** (SpO_2-message) value represents the current status of the parameter. A value of "00"is returned if no error is active. Refer to "Mode 1 — Real Time" on page 99 for a complete list of error messages.

To exit SpO_2 Waveform mode, the computer must send an ASCII "x" or "X" character. The CO_2SMO will echo "x" and stop communication.

Mode 5 — Dual Waveform

In Dual Waveform mode, the end tidal CO_2, respiratory rate, inspired CO_2 values, saturation values, and respiration rate are continually transmitted at one second intervals.

To enter dual waveform mode, the computer must send an ASCII "5" character. The CO_2SMO will echo the "5" followed by a <cr><lf> and then enable communication.
The data format is,

MS***P***Y**S***P***Z**<cr><lf> (sent once a second)
c++p++<cr><lf> (sent 48 times a second)

where;
M - Event Marker identifier, "M"= event marked, "-"= no event,
E - an identifier for the a 3-digit ASCII CO_2 value to follow,
R - an identifier for the 3-digit ASCII Resp. rate value to follow,
I - an identifier for the 2-digit ASCII Inspired CO_2 value to follow,
Y - an identifier for a 2-digit ASCII CO_2 status (message) value
S - an identifier for a 3-digit ASCII SpO_2 value to follow,
P - an identifier for a 3-digit ASCII Pulse value to follow,
Z - an identifier for a 2-digit ASCII SpO_2 status (message) value
*** - a 3-digit ASCII value,
** - a 2-digit ASCII value,
c - an identifier for a 2-digit waveform data point to follow,
++ - a 2-digit ASCII value (in the range 0-99),
p - an identifier for a 2-digit waveform data point to follow,
++ - a 2-digit ASCII value (in the range 0-99),
<cr><lf> - a carriage return, line-feed sequence.

Mode 6 — Trend Dump

Trend data is transmitted as a succession of records. The record size for CO_2SMO is 40 bytes of hexadecimal ASCII data. A record can be one of two types, an INFO record or a DATA record. The INFO record contains monitor information such as time of day, date, limit settings, and units. The DATA record contains $ETCO_2$, respiration rate, inspired CO_2, event marker, audio disable, SpO_2, and pulse rate values.

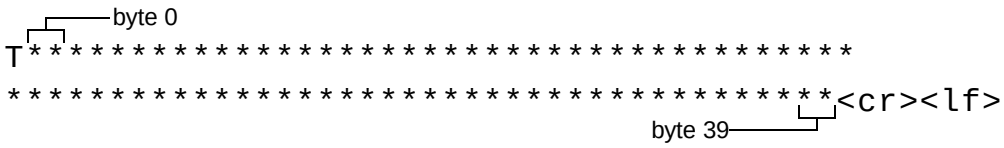
The first record sent is always an INFO record. This record reflects the oldest data in the buffer, then records would continue being sent in chronological order from the oldest record to the newest record. In normal monitoring use, an INFO record would be followed by 15 data records, followed by another INFO record and then another 15 data records, etc. Turning the monitor off, or changing the limits will disrupt this sequence. When this occurs a new INFO record will be sent and indicate the time and date, along with the current limits. At this point, unless another exception occurs, the next INFO record will be followed by 15 DATA records.

An INFO record can be distinguished from a DATA record by the first byte of the record. The first byte of an INFO record is FF, the first byte of a DATA record is 00-C8 (0-200 decimal), or FB (pen lift or no data available). Any other values are not applicable. The DATA record uses 8 data points per parameter, at 8 second resolution, for a total of 64 seconds of trend data per data record.

To request trend dump, the computer must send an ASCII "6" character. The monitor echoes back the "6" character and transmits the first INFO record.

The Mode 6 data format is:

INFO record:

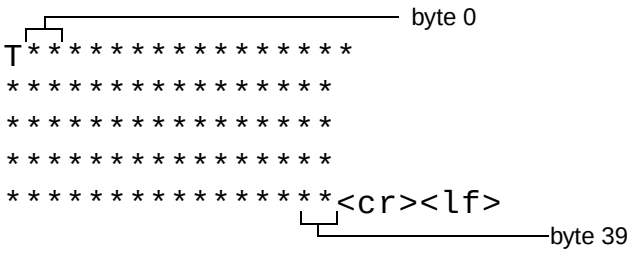


where:
T- Trend mode identifier
**-INFO byte, starting at byte 0 and ending at byte 39 (see below)

byte -0	flag byte = FF for INFO record
byte-1	information type (FE-power on, FD-limit change, FC-time stamp)
byte-2	model code = 1
byte-3	CO2 units (0=mmHg, 1=Kpa, 2=%)
byte-4	seconds 00-36 (0-59 decimal)
byte-5	minute 00-36 (0-59 decimal)
byte-6	hour 00-17 (0-23 decimal)
byte-7	day 01- 1F (1-31 decimal)
byte-8	month 01-0C (1-12 decimal)
byte-9	year 00-63 (0-99 decimal)
byte-10	End Tidal limit, high
byte-11	End Tidal limit, low
byte-12	Resp. Rate limit, high
byte-13	Resp. Rate limit, low
byte-14	SpO2 limit, high
byte-15	SpO2 limit, low
byte-16	Heart Rate limit, high
byte-17	Heart Rate limit, low
byte-18 through byte-39	unused

<cr> - carriage return
<lf> - line feed

DATA record:



T - Trend mode identifier
**-DATA byte, starting at byte 0 and ending at byte 39 (see below)

byte 0-7	8 byte ETCO2 data, range: units mmHg 0-100, units Kpa 0-133,units % 0-133, 251-no data available over period (pen lift)
byte 8-15	8 byte respiration rate data, range: 0-150, 251 - no data available over period.
byte 16-23	8 byte inspired data, range: 0-30, 31 - no data available over period. EVENT marker on if MSB is set. AUDIO off is 2nd MSB is set.
byte 24-31	8 byte SpO2 data, range: 1-100, 0-no data available.
byte 32-39	8 byte pulse rate data, range: 0-250, 251 - no data available over period.

<cr> - carriage return
<lf> - line feed

Mode d — Date and Time

Date and Time mode causes the CO_2SMO to transmit, on request, the date and time as calculated by the monitor's internal calendar clock.

To request the date and time, the computer must send an ASCII "d" character. The monitor echoes back the "d" character and sends the date and time on the same line. The Mode d data format is;

`d•MMM/DD/YY•hh:mm:ss<cr><lf>`

where;
`d` - the echoed command character
`•` - is an ASCII space character
`MMM` - a 3-character month (Jan, Dec),
`DD` - a 2-digit ASCII day (01, 31),
`YY` - the last 2-digits of the year (1990 is 90),
`hh` - a 2-digit hour based on a 24 hour clock (00, 23),
`mm` - a 2-digit minute,
`ss` - a 2-digit second,
`<cr><lf>` is a carriage return, line-feed sequence.

Mode c — Clear Trends

Clear Trends mode allows the user to remotely clear the CO_2SMO trend memory This action has the same result as the monitor's Clear Trend function in that trend memory and the Trend Page displays are cleared.

Note: Use this remote Clear Trends function with care as there is no way to undo the clear command once issued.

To clear the CO_2SMO trend memory, the computer must send an ASCII "c" character. The CO_2SMO will echo the "c" followed by a `<cr><lf>` and then the trend memory will be cleared.

Selecting NOVACOM1 Interface

To configure the CO_2SMO to work with the NOVACOM1 computer Interface:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Repeatedly press the **NEXT** key until MONITOR OPTIONS 2 appears.
3. Press the **SER** (serial interface) key and the currently selected interface appears.
   Available interfaces include INTERFACE UNUSED, PRINTER INTERFACE, NOVACOM1 INTERFACE, ANALOG MODULE INTERFACE, MEMORY CARD INTERFACE, TELECAP INTERFACE, and TELESAT INTERFACE.
4. Press **PREV** (previous) or **NEXT** to select NOVACOM1 INTERFACE.
5. Press the **SET** key.
   The NOVACOM1 Interface is selected.
6. Press **RUN** to return to the Main Menu.

Selecting Analog Module Interface

To configure the CO_2SMO to work with the Analog Module.

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Repeatedly press the **NEXT** key until MONITOR OPTIONS 2 appears.
3. Press the **SER** (serial interface) key and the currently selected interface appears.
   Available interfaces include INTERFACE UNUSED, PRINTER INTERFACE, NOVACOM1 INTERFACE, ANALOG MODULE INTERFACE, MEMORY CARD INTERFACE, TELECAP INTERFACE, and TELESAT INTERFACE.
4. Press **PREV** (previous) or **NEXT** to select ANALOG MODULE INTERFACE.
5. Press the **SET** key.
   The Analog Module interface is selected.
6. Press **RUN** to return to the Main Menu.

Connecting the Analog Module

The CO_2SMO must be configured for Analog Module Interface to operate with the Analog Output Module. See "Selecting Analog Module Interface" on page 105.

1. Connect the Analog Output Module to the monitor's rear panel RS232 connector.
2. Tighten the two spring loaded screws that secure the Analog Module to the rear panel.
3. Connect the interface cable to the Analog Module's 15 pin connector.

   The Interface Cable PN: 6045-00 connects to the 15 pin D connector on the Analog Module then terminates to six twisted pair wires. The six twisted pair wires on the open end of the interface cable correspond to channels 0-5 as listed below. Connect these wires to the analog recorder.

Channel	Parameter	Pin No.	Wire Pair	Specifications
0	End Tidal Value	1	Black/White	10 mv=1 Torr
1	Resp. Rate	3	Brown/White	7mv=1 breath/min
2	Capnogram	5	Red/White	10mv=Torr
3	Saturation Value	7	Orange/White	10mv=1%
4	Heart Rate	9	Yellow/White	4mv=beat/min
5	Plethysmogram	11	Green/White	not scaled (1v max)
-	Alert Output	15	-	active low

The White wire on all twisted pairs is the reference (ground).

Calibrating External Recorder

To set up external devices such as strip chart recorders by outputting zero, mid, and full scale reference voltages for each parameter. The Analog Module Interface must be programmed in order to proceed. See "Selecting Analog Module Interface" on page 105 and "Connecting the Analog Module" on page 106.

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Repeatedly press the **NEXT** key until MONITOR OPTIONS 2 appears.
3. Press the **REC** key, CALIBRATE RECORDER appears.

   If the Analog Module has not been programmed as a serial interface the **REC** will not appear. See "Selecting Analog Module Interface" on page 105.
4. Press **ZERO**, **HALF**, or **FULL** as desired.

   Press **ZERO** for zeroing all channels, this will program zero volts on all parameter channels.

   Press **HALF** for half scale, each parameter will be set to 0.5 volts.

   Press **FULL** for full scale, each parameter will be set to 1.0 volts.
5. Press **RUN** or **PREV** as desired.

   Press **RUN** to return to the Main Menu.
   Press **PREV** to return to MONITOR OPTIONS 2 menu.

The NOVACARD Memory Module

The CO_2SMO can store patient trend information and waveforms into a memory card through the use of the *NOVACARD* Memory Module. The *NOVACARD* Memory Module connects to CO_2SMO's rear panel RS232 connector, see "Selecting NOVACARD Interface" on page 107.The information stored in the memory card can then be read by a computer using the *NOVACARD* Reader. For more information on the *NOVACARD* Memory Module reference *NOVACARD* Memory Module Operator's Manual (Cat. No. 5962-23). For more information on the *NOVACARD* Reader reference *NOVACARD* Reader Operator's Manual (Cat No. 6062-23).

Selecting NOVACARD Interface

To configure the CO_2SMO to operate with the *NOVACARD* Memory Module.

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Repeatedly press the **NEXT** key until MONITOR OPTIONS 2 appears.
3. Press the **SER** (serial interface) key and the currently selected interface appears.

   Available interfaces include INTERFACE UNUSED, PRINTER INTERFACE, NOVACOM1 INTERFACE, ANALOG MODULE INTERFACE, NOVA CARD INTERFACE, TELECAP INTERFACE, and TELESAT INTERFACE.
4. Press **PREV** (previous) or **NEXT** to select NOVACARD INTERFACE.
5. Press RUN to return to the Main Menu.

   When *NOVACARD* Interface is selected, a **CARD** softkey is added to the SYSTEM OPTIONS menu. A STORE WAVEFORM TO CARD? prompt appears when the **EVENT** key is pressed and the waveform is frozen.

Connecting the NOVACARD Module

The CO_2SMO must be configured for *NOVACARD* Interface to operate with the *NOVACARD* Memory Module. See "Selecting NOVACARD Interface" on page 107.

1. Connect the NOVACARD Memory Module to the monitor's rear panel RS232 connector.
2. Tighten the two spring-loaded screws that secure the module to the rear panel.

   Ensure that there are no cards inserted at this time to allow access to the spring-loaded mounting screws.

Selecting TeleCap Interface

To select the Telecap Interface for the CO_2SMO:

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Repeatedly press the **NEXT** key until MONITOR OPTIONS 2 appears.
3. Press the **SER** (serial interface) key and the currently selected interface appears.

   Available interfaces include INTERFACE UNUSED, PRINTER INTERFACE, NOVACOM1 INTERFACE, ANALOG MODULE INTERFACE, MEMORY CARD INTERFACE, TELECAP INTERFACE, and TELESAT INTERFACE.

4. Press **PREV** (previous) or **NEXT** to select TELECAP INTERFACE.
   The Telecap interface is now selected for the CO_2SMO.
5. Press **RUN** to return to the Main Menu.

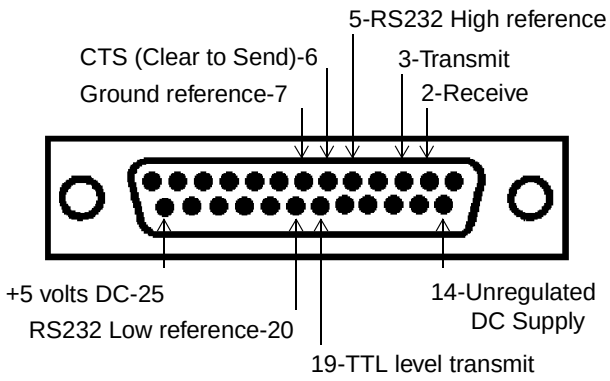
Selecting TeleSat Interface

To select the TeleSat Interface for the CO_2SMO.

1. Press and hold the **MENU** key for 3-seconds. CO2 SETUP OPTIONS appears.
2. Repeatedly press the **NEXT** key until MONITOR OPTIONS 2 appears.
3. Press the **SER** (serial interface) key and the currently selected interface appears.
   Available interfaces include INTERFACE UNUSED, PRINTER INTERFACE, NOVACOM1 INTERFACE, ANALOG MODULE INTERFACE, MEMORY CARD INTERFACE, TELECAP INTERFACE, and TELESAT INTERFACE.
4. Press **PREV** (previous) or **NEXT** to select TELESAT INTERFACE.
   The TeleSat interface is now selected for the CO_2SMO.
5. Press **RUN** to return to the Main Menu.

Rear Panel RS232C Pinout

The CO_2SMO rear panel RS232C connector's pinout is illustrated below.



Section 15 *Maintenance*

This section contains CO_2SMO monitor and accessory maintenance information.

Cleaning and Sterilization

Follow the cleaning and sterilization instructions listed below to clean and/or sterilize the monitor and its accessories.

Monitor

- Turn the monitor off and unplug the line cord from the AC power source before cleaning.
- The monitor can be cleaned and disinfected with solutions such as a 70% isopropyl alcohol, 2% gluteraldehyde, or 10% bleach solution. Then wipe down with a water-dampened clean cloth to rinse. Dry before use.
- Do not immerse the monitor.
- Do not attempt to sterilize the monitor.

SpO_2 Finger Sensor

- The sensor can be cleaned and disinfected with solutions such as a 70% isopropyl alcohol, 2% gluteraldehyde, or 10% bleach solution. Then wipe down with a water-dampened clean cloth to rinse. Dry before use.
- Make certain that the finger sensor windows are clean and dry before reuse.
- Do not immerse the finger sensor.
- Do not attempt to sterilize the finger sensor.
- After cleaning the finger sensor, verify that the sensor is physically intact, with no broken or frayed wires or damaged parts. Make certain that the connectors are clean and dry, with no signs of contamination or corrosion. Do not use a broken or damaged sensor or one with wet, contaminated or corroded connectors.
- Perform a “Quick Check” to verify the integrity of the sensor (See “Finger Sensor Quick Check” on page 35).

SpO_2 Y-Sensor

- Do not immerse connector on the Y-Sensor.

- The Y-Sensor may be immersed—up to, but not including, the connector, in a 2% gluteraldehyde solution, or 10% bleach solution. Refer to manufacturer's instructions and standard hospital protocols to determine recommended times for disinfection and sterilization.
- Rinse thoroughly with water and dry before use (do not rinse the connector).
- Do not attempt to sterilize Y-Sensor except as stated above.
- After cleaning or sterilizing the Y-Sensor, verify that the sensor is physically intact, with no broken or frayed wires or damaged parts. Make certain that the connectors are clean and dry, with no signs of contamination or corrosion. Do not use a broken or damaged sensor or one with wet, contaminated, or corroded connectors.
- Perform a "Quick Check" to verify the integrity of the sensor (See "Y-Sensor Quick Check" on page 41).

SpO_2 Y-Strip Tapes and Foam Wraps

- Treat Y-Strip Tapes and foam wraps in accordance with hospital protocol for single-patient use items.

Ear Clip

- Do not immerse the ear clip
- Clean the ear clip with a cloth dampened with 70% isopropyl alcohol. After cleaning wipe the ear clip down thoroughly with a clean water-dampened cloth to rinse.

CAPNOSTAT CO_2 Sensor

- Clean the sensor surface with a damp cloth.
- Ensure the sensor windows are clean and dry.
- Do not immerse the CAPNOSTAT CO_2 Sensor.
- Do not attempt to sterilize the CAPNOSTAT CO_2 Sensor.

Reusable Adult Airway Adapter

- The Adult Airway Adapter (Cat. No. 7007) may be cleaned by rinsing in a warm soapy solution, followed by soaking in a liquid disinfectant, or pasteurized, or cold sterilized (gluteraldehyde). It should then be rinsed out with sterile water and dried.
- The Adult Airway Adapter (Cat. No. 7007) may be sterilized using steam autoclave or ETO (ethylene oxide) gas methods. Be sure to use appropriate aeration times.
- Before reusing the adapter, ensure the windows are dry and residue-free, and that the adapter has not been damaged during handling or by the cleaning/sterilization process.

Reusable Neonatal Airway Adapter

- The Neonatal Airway Adapter (Cat. No. 7053) may be cleaned by rinsing in a warm soapy solution, followed by soaking in a liquid disinfectant, or pasteurized, or cold sterilized (gluteraldehyde). It should then be rinsed out with sterile water and dried.

- The Neonatal Airway Adapter (Cat. No. 7053) may be sterilized by ETO (ethylene oxide) gas. Be sure to use appropriate aeration times.
- Before reusing the adapter, ensure the windows are dry and residue-free, and that the adapter has not been damaged during handling or by the cleaning/sterilization process.

External Sampling System Components

- The Nasal Sampling Cannulas are single-patient use.
- The Sampling Airway Adapter with tubing (Cat. No. 5843) may be cleaned by rinsing in a warm soapy solution, followed by soaking in a liquid disinfectant. It should then be rinsed out with sterile water and dried.

Single Patient Use Airway Adapters

- Treat all single patient use airway adapters in accordance with hospital protocol for single patient use items.

Internal Sampling System Components

Acceptable fluids for cleaning/sterilizing the internal pneumatic parts of the Sampling System include; Isopropyl alcohol, Cidex[1] or equivalent, or a 5.25% water solution by weight of sodium hypochlorite (bleach).

CAUTION

Do not attempt to pump cleaning/sterilizing liquid with the sampling pump. This may cause accelerated wear on the pump bearings. Always flush liquids with a syringe as described in the following instructions.

To clean/sterilize the pumping system:

1. Turn the monitor off and disconnect the line cord.
2. Remove both the Sampling Inlet tubing set and the Sampling Exhaust tubing (if any).
3. Attach an exhaust port line (1/8 inch or 3/16 inch I.D. tubing) from the Sampling Exhaust port to a suitable container located below the bottom level of the monitor.
4. Use a 60 cc catheter tip syringe. Fit it to the Sampling Inlet connector. Flush the sterilizing solution slowly through the pumping system. Push the entire 60 cc of solution through the Sampling Inlet. Repeat this process two (2) more times—a total of 180 cc of solution.
5. Remove the syringe and leave the cleaning/sterilizing fluid within the sampling pump system for 30 minutes. This will disinfect. Follow sterilant manufacturers instructions for sterilization times.
6. After 30 minutes, fill the syringe with distilled water and flush the system three (3) times. Allow the cleaning/sterilization solution and distilled water to drain through the Sampling Exhaust output.
7. Push several syringes of air slowly through the system to ensure that most of the liquid has been drained.
8. Follow this with at least three (3) more pushes of distilled water, followed by at least two (2) more pushes of air to ensure that most of the distilled water has been drained.

1 Cidex is a trademark of Arbook, Inc.

9. Remove the syringe from the unit. Do not connect the Sampling Inlet tubing. Connect the line cord and turn the monitor on. Allow the sampling pump to operate for several minutes. This will help to remove any trapped water.
10. Connect a Sampling Tubing set to the Sampling Inlet.
11. Block the open end of the tubing with your finger. Alternate blocking and unblocking the tubing end at least ten (10) times. Use a quick, brisk motion when blocking and unblocking the tubing. Keep the tubing blocked and unblocked for several seconds at a time.
12. Repeat the same blocking and unblocking action with your finger on the Sampling Exhaust port.
13. Allow the Sampling System to run for at least 30 minutes without the Sampling Assembly tubing and the Sampling Exhaust tubing (if any) connected. This will speed dry the system pneumatics.
14. Once these cleaning/sterilization instructions have been completed, normal Sampling System operation can be resumed. See “Sampling Airway Adapter” on page 25.

Maintenance Schedules

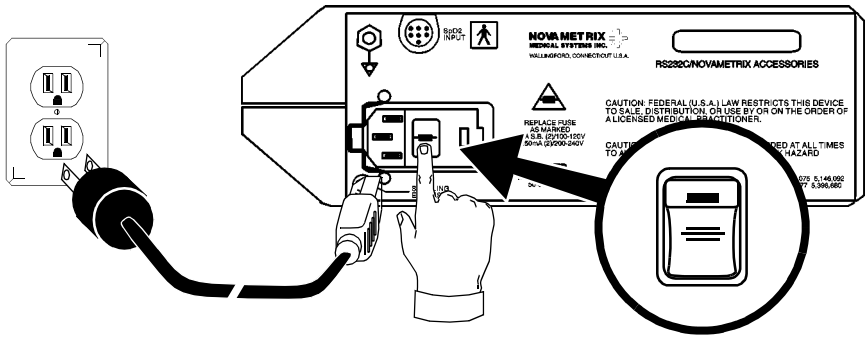
When the monitor powers up a self test is performed which checks the internal electronics of the monitor. If this self test fails, remove the monitor from use and contact qualified service personnel.

The monitor should undergo routine inspection and safety checks on a quarterly basis or according to hospital protocol. The CO_2SMO Service Manual (Catalog No. 5758-90) contains procedures and safety test instructions, component parts lists, circuit diagrams, theory of operation and other information to assist qualified service personnel in servicing the monitor.

Battery Maintenance

If the monitor has not been used or powered by AC mains for an extended time[2] (3 months or more) allow the battery to charge for 12 hours before use. The monitor may not power up on battery power if the battery is not sufficiently charged. Allow the battery to charge for 12 hours before initial use, refer to the following diagram for charging instructions.

To charge the battery, connect the line cord to an AC source and set the rear panel power switch ON (|). Check that the front panel ∿ icon is green. Charge the battery for 12 hours.


NOVAMETRIX
RS232C/NOVAMETRIX ACCESSORIES
CAUTION: FEDERAL (U.S.A.) LAW RESTRICTS THIS DEVICE TO SALE, DISTRIBUTION, OR USE BY OR ON THE ORDER OF A LICENSED MEDICAL PRACTITIONER.

2 The internal battery may slowly discharge over long periods of non-use.

If the battery requires replacement refer to the CO_2SMO Service Manual (Catalog No. 5758-90) for instructions. Have this procedure performed by qualified service personnel only, there are no user serviceable parts inside the monitor.

Mains Voltage Configuration

The rear panel power entry module indicates the mains voltage setting for the monitor. Check that the voltage is correct before attaching the AC line cord and powering the monitor. The CO_2SMO can be set to operate from 100-120 VAC 50/60Hz or 200-240VAC 50/60Hz.

Instructions for fuse replacement and changing the mains voltage setting follow.

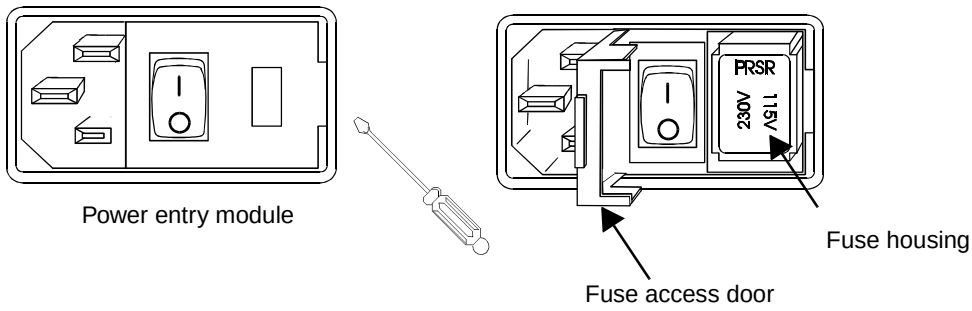
CAUTION

Replace fuses with same type and rating. Verify proper fuse value for mains voltage setting (see table below).

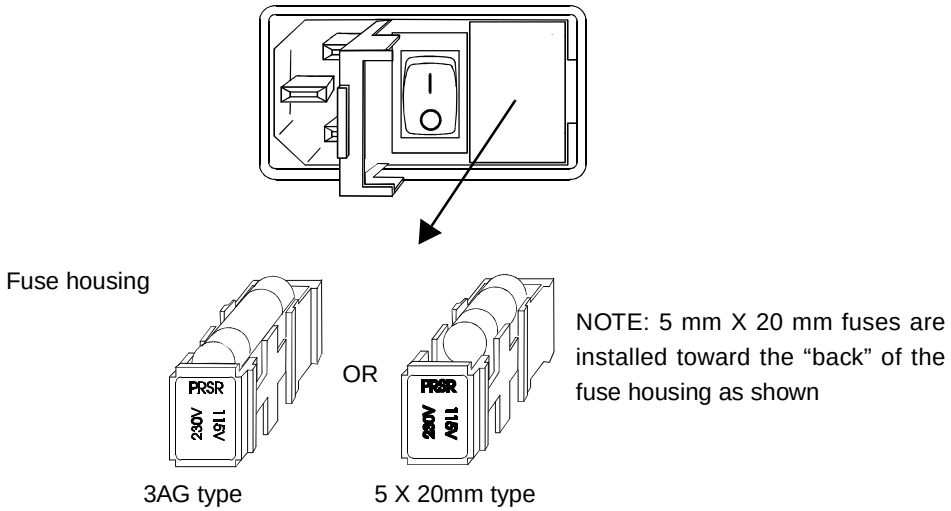
Fuse Replacement

1. Check that the monitor is OFF.
2. Set the rear panel power entry module switch to OFF (“O”). Remove the AC line cord from the power entry module.
3. Using a flat blade screwdriver, pry the fuse access door open to expose the fuse housing. Note the orientation of the fuse housing (this determines the mains operating voltage).

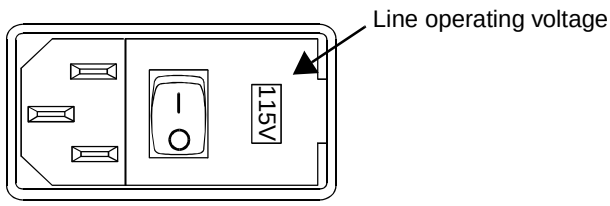
Mains Voltage	Fuses (Slo Blo)
100-120 Vac	0.5 A 250V
200-240 Vac	250mA 250V



4. Pry the fuse housing out from the power entry module.



5. Replace the blown fuse(s) with the proper type and rating.
6. Reinstall the fuse housing. When positioning the housing into the power entry module make sure that it is oriented correctly. Press the fuse housing back into the power entry module.
7. Close the fuse access door and verify that the proper mains operating voltage is displayed.



Section 16 *Specifications*

General

Specifications for the Novametrix CO_2SMO $ETCO_2/SpO_2$ Monitor, Model 7100, are listed for informational purposes only, and are subject to change without notice.

Capnograph

- Principle of Operation: Non-Dispersive Infrared (NDIR) absorption, dual wavelength ratiometric-True Single Beam Optics
- Sensor Type: "Mainstream" system eliminates the need for and cost of sample lines, water traps, and waste gas scavenging
- Warm-up Time: Operational in 30 seconds, 20 minutes to full specification.
- Response Time: Less than 75 ms
- Calibration: Simple one step calibration (less than 20 seconds)
- O_2/N_2O Compensation: Operator selectable
- Barometric Pressure Compensation: Automatic and manual over-ride (range 550-780 mmHg)[1]
- CAPNOSTAT® CO_2 Sensor and Airway Adapter:
  Weight: Less than 2 oz. (57 grams) without cable
  Sensor Size: 1 3/4 x 1 1/2 x 3/4 inches, 10 foot cable (4.45 x 3.81 x 1.91 cm, 3.05 m cable)
  Construction: Durable high performance plastic, ultra-flexible cable
  Shock Resistant: Sensor will withstand a 6 foot drop to a tile floor
- Airway Adapter: Disposable or reusable, less than 5 cc deadspace, meets ANSI Z-79
- End Tidal CO_2
  Range: 0-100 mmHg, CO2 partial pressure
  Accuracy: 0-40 mmHg ± 2 mmHg, 41-100 mmHg 5% of reading
  Stability: ± 2 mmHg
  Display Resolution: 0-50 mmHg scale 0.9 mmHg, 0-75 mmHg scale 0.6 mmHg
- Respiratory Rate
  Range: 0-150 br./min
  Accuracy: ± 1 br./min

1. Monitors with version 1.9 software do not have automatic barometric pressure compensation, pressure compensation is manually selectable from 550-780 mmHg. Monitors with version 1.9 software are identified by an "L" in the serial number suffix.

Oximeter

- Oxygen Saturation
  Range: 0-100%
  Accuracy: 80-100% ± 2%, 0-79% unspecified (Approximately 68% of the observations are within the accuracy claim.)
  Display Resolution: 1%
  Averaging Time: Menu selectable 2 or 8 seconds
- Pulse Rate
  Range: 30-250 beats per minute (bpm)
  Accuracy: ± 1% of full scale (Approximately 68% of the observations are within the accuracy claim.)
  Display Resolution: 1 bpm
  Averaging Time: fixed at 8 seconds

Monitor Specifications

- Operating Environment: 50-104° F (10-40° C), 0-90% relative humidity (non-condensing)
- Size: Height 3.3 in. (8.38 cm), Width 9 in. (22.86 cm), Depth 8 in. (20.32 cm)
- Weight: 8 pounds (3.63 kg)
- Power: 100-120/200-240 VAC, 50-60 Hz, 40VA
- Fuse Rating: 100-120 VAC, 0.5 A 250 V Slo-Blo (x2); 200-240 VAC, T 250 mA/250 V (x2)
- Battery: Lead-acid gel-cell, 2 hour life (on-screen life indicator), recharge 12 hours
- Display: SuperBright™ 1.5 x 5 inch (3.08 x 12.7 cm) Cold Cathode Display (CCD)

Additional Features

- Audible SpO_2 Trend Feature: Pitch of Pulse Rate "beep" tracks the SpO_2 value, user selectable.
- Alert Limits: Operator selectable, automatic or menu selected High and Low limits for $ETCO_2$, Respiratory Rate, SpO_2 and Pulse Rate. Visible alert is immediate, audible alert occurs 10 seconds after violation of set limit
- 2-Minute Silence: When **AUDIO** key is pressed, deactivates audible alerts for two minutes. Indicated by illuminated (2 minute LED)
- Audio Off: Press and hold **AUDIO** key for 3 seconds to deactivate audible alerts. Indicated by flashing (Audio Off LED)
- Trend Memory: 24 hour trend memory capacity. Battery backed. On-screen 12 hr., 8 hr., 2 hr., or 30 minute graphical and histogram displays. User defined Events are stored in memory. Trend and Histogram information can be printed.
- Digital Data Output: Serial (RS232) data output compatible with Hewlett-Packard ThinkJet Printer, Seiko DPU-411 Thermal Printer, Computer Interface
- Analog Output Module (Optional): Provides outputs for strip chart recorder applications CO_2 10 mV/Torr, Respiratory Rate 7 mV/br./min., Capnogram 0-1.0 V max, SpO_2 10 mv/%, Pulse Rate 4 mV/bpm, Plethysmogram 0-1 V max
- Sampling System: Standard. Allows gas sampling of non-intubated patients
- Neonatal Airway Adapter: Less than 0.5 cc deadspace
- Internal Real Time Clock
- Alert Bar
- NOVACARD Interface for data archiving (optional)

Section 17 *Accessories*

CO_2SMO Capnograph and Pulse Oximeter

Catalog No. **Description**

CO_2SMO is a combined Capnograph and Pulse Oximeter Monitor. It provides reliable mainstream measurement and display of end tidal carbon dioxide ($ETCO_2$) and respiratory rate. The CAPNOSTAT® CO_2 Sensor features rugged solid-state construction and is small and lightweight. Reusable, sterilizable low dead-space airway adapters are available for monitoring adults, neonates and non-intubated patients. *CO_2SMO*'s pulse oximeter provides reliable measurement and display of the percentage of oxygen saturation of arterial blood (SpO_2) and pulse rate. Reusable finger and Y-Sensors™ are available for adult, pediatric and neonatal monitoring applications. The monitor provides a selectable capnographic or plethysmographic waveform, on-screen trending and histogram display of $ETCO_2$, respiratory rate, SpO_2 and pulse rate, for up to 24 hours. A calendar/clock allows events, and the time they occur, to be marked in trend memory. RS232 computer and printer interfaces are standard. *CO_2SMO* uses a large SuperBright Cold Cathode Display (CCD), has a built-in combination kickstand and bedrail hanger, and can operate from AC power or its internal two hour battery. A sampling system for non-intubated patients is standard.

5758-00 ***CO_2SMO* $ETCO_2$/SpO_2 Monitor, Model 7100** with CAPNOSTAT CO_2 Sensor (Cat. No. 7167) and Oxy*Snap*™ SuperBright Finger Sensor (Cat. No. 8744)

CAPNOSTAT CO_2 SENSOR

7167-00 **CAPNOSTAT CO_2 Sensor** with Adult Airway Adapter (Cat. No. 7007) and (5 ea.) Sensor Cable Holding Clips (Cat. No. 8751)

AIRWAY ADAPTERS

7007-00 **Adult Airway Adapters** (10 per box)

7053-00 **Neonatal Airway Adapters** (10 per box)

5843-01 **Sampling Airway Adapters with tubing** (1 per box)

5843-30 **Sampling Airway Adapters with tubing** (3 per box)

5843-50 **Sampling Airway Adapters with tubing** (5 per box)

5843-00 **Sampling Adapters with tubing** (10 per box)

6063-00 **Pediatric/Adult Single Patient Use Airway Adapters** (10 per box)

6063-25 **Pediatric/Adult Single Patient Use Airway Adapters** (25 per box)

6421-00 **Pediatric/Adult Single Patient Use Airway Adapters with mouthpiece** (10 per box)

Catalog No.	Description
6421-25	**Pediatric/Adult Single Patient Use Airway Adapters with mouthpiece** (25 per box)
6312-00	**Neonatal/Pediatric Single Patient Use Airway Adapters** (10 per box)
6312-25	**Neonatal/Pediatric Single Patient Use Airway Adapters** (25 per box)

SINGLE PATIENT USE AIRWAY ACCESSORIES

8781	**Nasal CO_2 Sampling Cannula—Adult** (10 per box)
8780	**Nasal CO_2 Sampling Cannula—Pediatric** (10 per box)
8906	**Nasal CO_2 Sampling and O_2 Delivery Cannula—Adult** (10 per box)
8907	**Nasal CO_2 Sampling and O_2 Delivery Cannula—Pediatric** (10/box)
8908	**Nafion® Dehumidification Tubing** (10 per box)
8909	**Sidestream Monitoring Kit for Pediatric Tracheostomy Patients** (10 per box)

SINGLE PATIENT USE SpO_2 SENSORS AND CABLES

6455-00	**Pediatric/Adult Single Patient Use SpO_2 Sensor** Terminates in DB9 connector (10 per box)
6455-25	**Pediatric/Adult Single Patient Use SpO_2 Sensor** Terminates in DB9 connector (25 per box)
6480-00	**Neonatal/Pediatric Single Patient Use SpO_2 Sensor** Terminates in DB9 connector (10 per box)
6480-25	**Neonatal/Pediatric Single Patient Use SpO_2 Sensor** Terminates in DB9 connector (25 per box)
8933-00	**DB9 Extension Cable** For use with Single Patient Use sensor above
8936-00	**DB9/OxySnap Connector cable** Use to connect Single Patient Use sensors to OxySnap connector

Oxy*Snap*™ SpO_2 SENSORS

8793	**Oxy*Snap* Y-Sensor** (use with **Oxy*Snap*** Extension Cable)
8744	**Oxy*Snap* Finger Sensor** (use with **Oxy*Snap*** Extension Cable)
8853	**Oxy*Snap* Extension Cable**, 8 ft. (use with **Oxy*Snap*** sensors)
8898	**Oxy*Snap* Long Extension Cable**, 12 ft. (use with **Oxy*Snap*** sensors)

Oxy*Snap* SENSOR ACQUISITION PLANS

Select an Oxy*Snap* Finger Sensor or Y-Sensor Plan for each SuperBright™ Pulse Oximeter. The plan you select determines the warranty period—12, 24 or 36 months.

How the Plans Work: Included in each Plan are TWO sensors—one for immediate use, the other one for back-up. If a sensor becomes inoperative, place the back-up sensor into use and return the inoperative sensor in the convenient pre-paid mailer. A replacement sensor will be shipped within two business days of receipt of the inoperative sensor. This simple return/replacement method will be used for the entire warranty period, thereby, guaranteeing your costs and virtually eliminating sensor tracking hassles.

Warranty: The Plan warranty (not individual sensors) is 12, 24 or 36 months. Replacement sensors provided under terms of the Plan shall carry the remaining Plan warranty—replacements do not extend the warranty.

Catalog No.	Description
8793-12	**Y-12 Plan** The Plan warranty is 12 months. Includes 3 boxes (your choice) of any Y-Strip Taping Systems
8793-24	**Y-24 Plan** The Plan warranty is 24 months. Includes 6 boxes (your choice) of any Y-Strip Taping Systems
8793-36	**Y-36 Plan** The Plan warranty is 36 months. Includes 9 boxes (your choice) of any Y-Strip Taping Systems
8744-24	**Finger-24 Plan** The Plan warranty is 24 months.
8744-36	**Finger-36 Plan** The Plan warranty is 36 months.

Y-SENSOR APPLICATORS (tapes, wraps, earclips)

8828	**20mm Wrap Style Taping System** (100 per box) Use on neonatal foot and hand, or on pediatric toe or finger 20mm tapes use Blue color coded liners
8829	**25mm Wrap Style Taping System** (100 per box) Use on neonatal foot and hand 25mm tapes use Green color coded liners
8831	**20mm Finger Style Taping System** (100 per box) Use on pediatric finger or on small adult finger 20mm tapes use Blue color coded liners
8832	**25mm Finger Style Taping System** (100 per box) Use on adult finger 25mm tapes use Green color coded liners
6929	**Adhesive Foam Wraps** - Large (25 per box)
6968	**Adhesive Foam Wraps** - Small (25 per box)
8836	**Non-Adhesive Foam Wraps** - Large (25 per box)
8943	**Non-Adhesive Foam Wraps** - Small (25 per box)
6131-50	**Ear Clips** (5 per box)
6131-25	**Ear Clips** (25 per box)
8700	**Adhesive Dots** (250 per box)

OTHER SpO_2 SENSORS

8776	**SuperBright™ Finger Sensor** (10 ft. sensor cable)
8791	**SuperBright™ Y-Sensor** (10 ft. sensor cable)
8789	**Special Use SuperBright™ Finger Sensor** (8 inch sensor cable)
5238	**Special Use SuperBright™ Finger Sensor** & 25 ft. shielded cable

PRINTERS

9140-00	**Seiko DPU-414 Thermal Printer**, with battery pack
5140-00	**Hewlett-Packard ThinkJet Printer** (discontinued)
9028-00	**Cable** to Seiko DPU-414 Printer, 9 to 15 pin, (Model 511M)
9085-00	**Cable** to Seiko DPU-414 Printer, 9 to 25 pin, (Model 515A/520A/860/1265/7100)

Catalog No.	Description
9086-00	**Cable** to Seiko DPU-414 Printer, 9 to 9 pin, (Model 610)
5331	**Cable** to Hewlett-Packard ThinkJet Printer
300013	**Hewlett-Packard ThinkJet Printer Ink Cartridge**
300014	**Hewlett-Packard ThinkJet Printer Paper** (2500 sheets Z-fold)
300017	**Seiko DPU-414/411 Thermal Printer Paper** (5 rolls per box)
400051	**Seiko Battery Pack**
400052	**AC Adapter**, 120 VAC
400053	**AC Adapter**, 100 VAC
400054	**AC Adapter**, 230 VAC

ACCESSORIES

6064-00	**NovaCARD Startup Kit** (includes 1 each, Writer module, Reader module, SRAM Memory Card (128k), and NovaCARD for MS-DOS® software). NovaCARD—Computer Archive, Recall and Display—is a hardware/software combination that allows users to transfer patient trend data, user-stored waveforms, and monitored parameter values, from supported Novametrix monitors to a personal computer.
5962-00	**NovaCARD Writer Module** (connects to Novametrix monitor)
6062-00	**NovaCARD Reader Module** (includes power supply and cable to PC serial port)
6065-00	**NovaCARD for Windows®** (3½" disk and RTU license)
6066-07	**NovaCARD for MS-DOS®** (3½" disk and RTU license)
6068-07	**SRAM Memory Card**, 128k-byte
600048	**Cable**, connects NovaCARD Reader to PC (6 ft)
600049	**Cable**, PC Serial Port adapter (25-to-9 pin, 1 ft)
6064-81	**NovaCARD** warranty extended an additional 1 year at time of purchase, hardware only, SRAM cards not included.
9622	**Analog Module** (includes RS232 pass-thru)
7106-10	**Transport Pouch** (for *CO_2SMO*)
7104-10	**Side Pouch** for accessories (included with monitor)
8751	**CAPNOSTAT CO_2 Sensor Cable Holding Clips** (50 per box)
600026	**Power Cord** (included with monitor)
4941	**Saturation Sensor Extension Cable**—4 feet
4942	**Saturation Sensor Extension Cable**—6 feet
4943	**Saturation Sensor Extension Cable**—10 feet
5266	**Saturation Sensor Extension Cable**—25 feet
5334	**Cable** Serial Output to Personal Computer (with 25-pin connector)
5335	**Cable** Serial Output to Personal Computer (with 9-pin connector)
4832	**Cable** RS232/SARA/SARAcap Interface
	Custom Cables—Consult factory for specifications and pricing

Catalog No.	Description
	MOUNTING SYSTEMS
140030	**Wall Mount**
140031	**Wall Mount** (less Wall Channel)
140032	**Pivot Block Mount**
140033	**Transport Mount** (without swivel head)
140034	**Transport Mount** (with swivel head)
140035	**Countertop Mount** 11 inch Base
140036	**Countertop Mount** 5 inch Base
140037	**Portable Instrument Housing**
140038	**Rollstand**
140082	**T-Mount Bracket for Rollstand**
	EXTENDED WARRANTY
	Normal warranty: Monitor & CAPNOSTAT CO_2 Sensor—1 yr, Finger Sensor—6 mo
5758-81	***CO_2SMO* Capnograph and Pulse Oximeter, Model 7100** (Total Warranty: Monitor—2 years)
5758-85	***CO_2SMO,* Model 7100 with CAPNOSTAT CO_2 Sensor** (Cat. No. 7167) (Total Warranty: Monitor—2 years, CAPNOSTAT—2 years, Finger Sensor Cat. No. 8744—1 year)
7167-82	**Additional 7167 when monitor is covered** (Total Warranty: CAPNOSTAT CO_2 Sensor—2 years)
8744-83	**Additional 8744 when monitor is covered** (Total Warranty: Finger Sensor—2 years)
	BIOMEDICAL TEST KIT
	Service Test Kits include items and materials qualified service personnel may require to determine the functional integrity and/or accuracy of the system.
5779-00	***CO_2SMO* Service Test Kit, Model 7100** (Other kits available, contact Novametrix Service Department)
9999-96	**"Focus" Technical Training Seminars** (For class schedules call: 1-800-243-3444 Ext. 2567)

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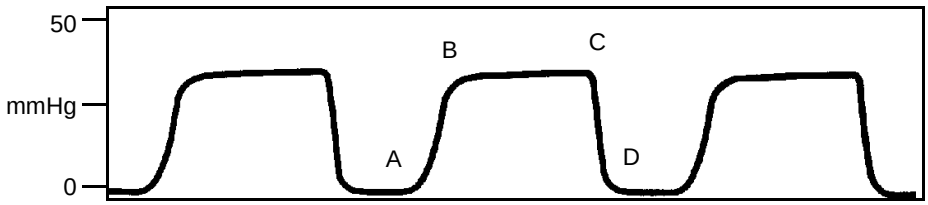
Section 18 *Typical Capnogram Waveforms*

Normal Waveform

The “normal” capnogram provides a waveform of changing levels of expired CO_2.

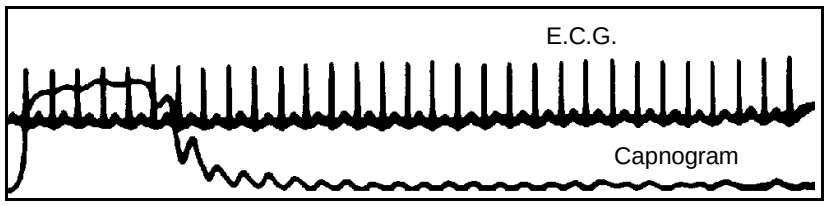


Waveform evaluation:

- A-B: Ascending limb, expiratory portion, mixed deadspace and alveolar air with increasing concentration of CO_2. Normally starts at a baseline of zero.
- B-C: Alveolar plateau contains mixed alveolar gas with End Tidal measured at C.
- C-D: Descending limb, inspiratory portion, with decreasing concentration of CO_2. Normally returns to a baseline of zero.

Cardiogenic Oscillations

Cardiogenic oscillations appear during the final phase of the alveolar plateau and during the descending limb. They are caused by the heart beating against the lungs.

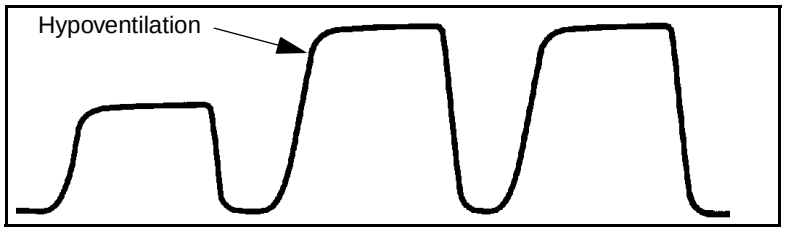


Characteristics:

- Rhythmic and equal to heart rate
- May be observed in pediatric patients mechanically ventilated at low respiratory rates with prolonged expiratory times

Hypoventilation

An increase in the level of the End Tidal CO_2 from previous levels.

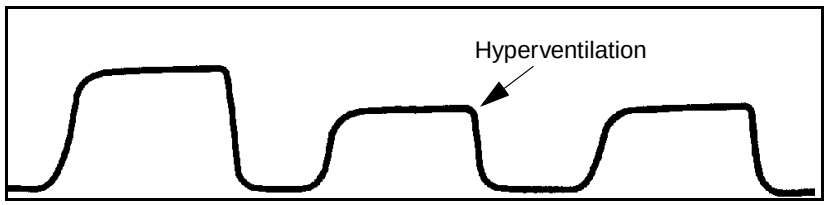


Possible Causes:

- Decrease in respiratory rate
- Decrease in tidal volume
- Increase in metabolic rate
- Rapid rise in body temperature (malignant hyperthermia)

Hyperventilation

An decrease in the level of the End Tidal CO_2 from previous levels.

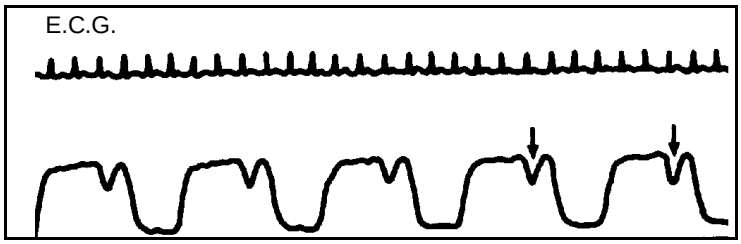


Possible Causes:

- Increase in respiratory rate
- Increase in tidal volume
- Decrease in metabolic rate
- Fall in body temperature

Muscle Relaxants

Clefts are seen in the final third portion of the alveolar plateau. They appear when the action of the muscle relaxants are affected by spontaneous ventilation.

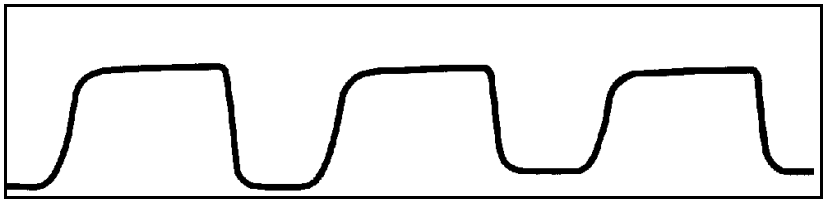


Characteristics:

- Depth of the cleft is inversely proportional to the degree of drug activity
- Position fairly constant on same patient but may not be present in every capnogram

Rebreathing

Rebreathing is characterized by an elevation in the baseline with a corresponding increase in End Tidal CO_2. It indicates the rebreathing of the previously exhaled CO_2.



Possible Causes:

- Insufficient expiratory time
- Faulty expiratory valve
- Inadequate inspiratory flow
- Malfunction of a CO_2 absorber system
- Partial rebreathing circuits

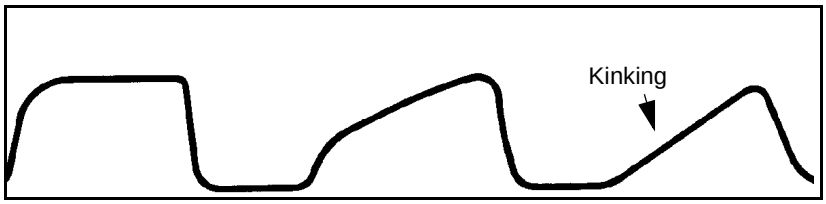
Obstruction in Breathing Circuit or Airway

An obstruction to the expiratory gas flow noted as a change in the slope of the ascending limb of the capnogram. The expiratory portion may diminish without a plateau.

Possible Causes:

- Partial obstruction in the expiratory limb of the breathing circuit
- Presence of a foreign body in the upper airway
- Partially kinked or occluded artificial airway
- Herniated endotracheal/tracheostomy tube cuff
- Bronchospasm

Endotracheal Tube Kinked



Waveform Evaluation:

- Any obstruction will cause an abrupt change in the ascending limb resulting in either a diminished plateau or no plateau. $ETCO_2$ and slope will depend on the degree of obstruction.

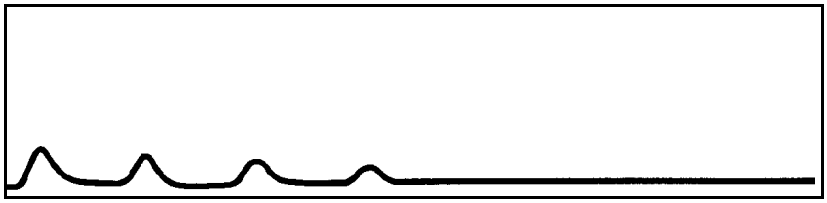
Inadequate Seal Around Endothracheal Tube

A capnogram in which the downward slope of the plateau blends in with the descending limb.

Possible Causes:

- A leaky or deflated endotracheal or tracheostomy cuff
- An artificial airway that is too small for the patient

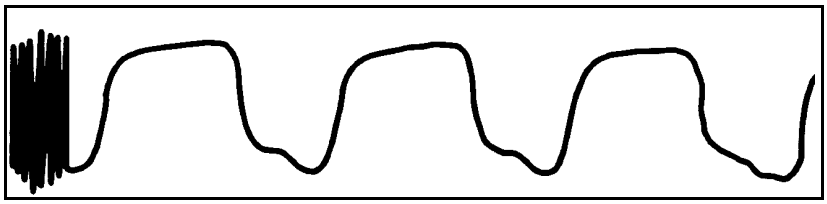
Endotracheal Tube in Esophagus



Waveform Evaluation:

- A normal capnogram is the best available evidence that the ET tube is correctly positioned and that ventilation is occurring. When the ET tube is placed in the esophagus, either no CO_2 is sensed or only small transient capnograms are present.

Faulty Ventilator Circuit Valve



Waveform Evaluation:

- Baseline elevated
- Sloping descending limb of capnogram
- Allows patient to rebreathe exhaled gas

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